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ABSTRACT

The purpose of this research was to develop methods to study the effects of context on children's comprehension and production of temporal terms such as "before," "after," "next," "then," and "but first." A longitudinal study, using naturalistic and traditional laboratory methods, and three cross-sectional studies were conducted with children between the ages of two-and-a-half and four. Most of the studies examined aspects of the Semantic Feature Hypothesis (the only stage theory of lexical acquisition that has been extensively tested with children's understanding of temporal terms). The main findings from both the longitudinal and cross-sectional studies were: (1) children understand temporal order through a sentence's inherent meaning; (2) although children will perform better on act-out sentences conjoined by "before," the Semantic Feature Hypothesis is inadequate in explaining the results; (3) some children will use a main-clause-first strategy in acting out temporal sentences, whereas other children will use a first-clause-first strategy; and (4) children use many routes to lexical mastery. The longitudinal analyses support the methodological claim that repeated measures on the same children yield a much richer picture of lexical and conceptual development. Appended are sections on the following topics: (1) spontaneous usage of searched temporal terms; (2) copies of test forms as administered; (3) unfamiliar temporal connectives: a test of the first-clause-first strategy; (4) a comparison of young children's comprehension and memory for statements of temporal relations; and (5) lexical development: a mini-longitudinal approach. (Author/NCR)

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ED159908

FINAL REPORT

Contextual Variation in Linguistic Performance

March 17, 1978

Joyce Weil

Yeshiva University and The Rockefeller University

and

Mary Jo Altom

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This document is a review of work accomplished under Grant No. 4-0479 from the National Institute of Education to Yeshiva University. This review covers the data collection period from September, 1974 to November, 1975. Data analyses have continued until the present with additional funds from Grant No. GM21796 from the Public Health Service, National Institute of General Medical Sciences to The Rockefeller University and Grant No. 5-29284 from The William T. Grant Foundation to The Rockefeller University.

Summary

The purpose of this research was to develop methods to study the effects of context on children's comprehension and production of temporal terms -- words such as before, after, next, then, but first. A longitudinal study using naturalistic and traditional laboratory methods as well as three cross-sectional studies were conducted with children between the ages of two-and-a-half and four. Most of the studies examined aspects of the Semantic Feature Hypothesis -- the only stage theory of lexical acquisition which has been extensively tested with children's understanding of temporal terms.

The main findings from both the longitudinal and cross-sectional studies were: (1) children understand temporal order through a sentence's inherent meaning. It is only when children have to act-out sentences in which the order of events is arbitrary that they show confusions or omissions of clauses; (2) although children will perform better on act-out sentences conjoined by before, the Semantic Feature Hypothesis is inadequate in explaining the results. Data from studies using nonsense words and analyses from children's omissions indicate that there is a response bias toward before; (3) some children will use a main-clause-first strategy in acting-out temporal sentences whereas other children will use a first-clause-first strategy. The same children do not use either strategy consistently; (4) children use many routes to lexical mastery. No other stage theory can predict temporal lexical development for individual children. The longitudinal analyses support the methodological claim that repeated measures on the same children yield a much richer picture of lexical and conceptual development.

ACKNOWLEDGMENTS

Many people contributed to the research presented in this report. We are particularly indebted to Keith Stenning and Mark Altom for their continuous advice and suggestions throughout the data collection period. Many graduate students at Yeshiva University helped in various phases of data collection. In addition to the students who are acknowledged in the appropriate sections of this report, we are grateful to the students in the school psychology program for administering the Stanford-Binet to the children in our longitudinal sample, to Alice Florance who is presently replicating aspects of the longitudinal study, and to Amy Adler who analyzed much of the production data.

We are especially grateful to George A. Miller who generously gave of his time and provided the necessary research facilities and support to carry out this study. In addition, he has provided an invaluable service to us by summarizing this research in his book Spontaneous Apprentices: Children and Language, New York: The Seabury Press, 1977. His summary in the chapters "Time" and "Before and After" makes the data of this report not only available to a wide audience but also presents it in the context of questions and problems psychologists face in studying children's language acquisition.

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1. Overview

The purpose of this research was twofold: (1) to develop methods to study the effects of context (linguistic and extra-linguistic) in the assessment of children's linguistic skills in the temporal domain; (2) to conduct studies (both longitudinal and cross-sectional) on the cognitive basis of the development of temporal terms.

The expression of temporal relations in children's language acquisition is a particularly important area of research, since the referent of its expressions is abstract and intangible. Most research on children's lexical development has dealt with the acquisition of expressions which have tangible referents. Thus, this area of research becomes particularly important not only because the temporal domain in English is very complex linguistically, but because studying the development of temporal relations may serve as a prototype for studying the acquisition of abstract ideas.

Although English has four major systems for talking about time - tense, aspect, auxiliary verbs and time adverbials, the bulk of the research supported under this grant concerned the development of time adverbials - expressions such as before, after, next, and then, but first, when, and while.

Most research on children's development of temporal adverbials has dealt with the acquisition of before and after. However, these terms are only two of several available for expressing relations between two temporal events. The conceptual meanings of before and after overlap with those of other temporal terms (e.g.

and then and but first) although their grammatical roles within a sentence differ. One concern of this study was to examine how children comprehend and express relations between two temporal events. We not only studied the development of before and after but also and then, but first, while, next, and until to find out how these words evolve together in order to express the child's developing concepts of time and temporal relations.

A basic assumption underlying the overall design of this research is that different linguistic tasks may lead a child to formulate different hypotheses about the concepts in question. Therefore, different contextual information may impede or facilitate his utilization of sentential information. Thus, a second concern in this study was to explore possible contextual and situational cues which may impede or facilitate the child's comprehension and production of temporal terms. Syntactic, semantic, and pragmatic aspects of temporal comprehension were varied. For example, we contrasted children's comprehension for both imperative and declarative temporal sentences (syntactic variations); we looked at children's comprehension of meaningful and anomalous temporal sentences (semantic); and we studied their comprehension in a variety of social settings (pragmatic).

There have been several theoretical accounts of semantic development in general -- the grammatical relations hypothesis (McNeill, 1970); the generalization hypothesis (Anglin, 1970); the semantic feature hypothesis (Clark, 1973); as well as several specific theoretical accounts attempting to explain observed differences in comprehension between before and after (Clark, 1971;

Smith and McMahon, 1970; Bever, 1970; Weil, 1970). However, none of these accounts have withstood all the tests of empirical validation. Depending on the conceptual and linguistic requirements of the experimental tasks, different experimenters have reported data in support of one or the other hypotheses. (See appendix A, pp. 13-20 for a review of this literature.)

Although the procedures used in this study did not restrict themselves to a verification of any theory of lexical development, Clark's (1973) Semantic Feature Hypothesis was referred to the most often since her theory has been the most extensively tested. There is one important assumption within her theory and other theories of lexical development which we were able to test using our experimental design -- specifically, that lexical development proceeds through a series of hierarchical stages. Such an assumption implies that an individual child will pass through each stage in an orderly progression. A third concern of this research was to examine if individual children progress through a series of orderly stages in temporal acquisitions.

To answer this question a "mini-longitudinal"[1] study was designed. Since we were only interested in the acquisition of one lexical domain -- temporal adverbials -- and since funds were available for only one year, we limited our sample size -- 17 children -- but chose a broad age span. (In the final sample, there was a one and one half year age difference between our youngest and oldest child.) At the youngest ages we hoped to

[1]The term minilongitudinal was adopted to emphasize the limited time period in data gathering -- seven months. Traditionally, longitudinal studies have extended for a much longer period of time.

trace the first six months of temporal acquisition and at the oldest ages, we hoped to trace the beginnings of temporal mastery -- how the child progresses from partial meanings to the beginnings of adult comprehension. Previous research (e.g. Cromer, 1969; Clark, 1967) led us to believe that the ages from 2;6 to 3;0 would be suitable for later acquisition. During the seven month period each child was assessed at regular intervals with a series of temporal tasks which have been used in classical studies of the development of before and after. Thus, in addition to the wide variety of tasks used to look at the effects of contextual cues (both linguistic and extranlinguistic) in impeding or facilitating temporal development, we were able to investigate longitudinally the stage assumption underlying many of the theories of lexical development.

To summarize, the three main concerns of this study were: (1) to investigate the development of the major temporal connectives (e.g. before, after, and then, but first); (2) to investigate the syntactic, semantic and pragmatic variations in the comprehension and production of these terms; (3) to investigate whether individual children progress in an orderly hierarchical sequence in the development of these terms.

The body of this report will: (1) summarize the overall design of the longitudinal study (general procedure, sample, setting); (2) summarize each of the measures developed to assess temporal acquisitions as well as their specific findings; (3) summarize the results of mini-experiments conducted with the longitudinal sample; (4) summarize the results of cross-sectional studies undertaken to replicate some of the longitudinal data. For each of the above summaries, detailed accounts may be found in the appendices.

2. Method

2.1 Design of mini-longitudinal study.

The central problem was to examine how children comprehend and express temporal events in a variety of contexts. The general strategy was to study longitudinally in both a playgroup situation (naturalistic) and a laboratory situation a group of children who visited the Rockefeller University Child Language Research Facility each week for a seven month period.

During this period (October, 1974-May, 1975) each child was tested repeatedly in the laboratory situation with a variety of measures on his ability to comprehend and imitate a series of sentences describing two temporal events. The seven month data collection period was divided into four separate assessments. Each assessment period was separated by a 6-7 week period. In the playroom children were engaged in conversations about temporal events. In addition, several structured tasks resembling those given in the laboratory situation were given. Table 1 summarizes the design of the study.

2.2 The Sample.

In October, 1974, 17 children (8 boys and 9 girls) between the ages of 2;3 and 3;11 were enrolled at The Rockefeller University Child Language Research Facility. At the first assessment period, the youngest child was 2;4 and the oldest was 4;0. The IQ scores which were obtained during the third assessment period ranged from 111 to 154. The majority of the subjects were children of physicians at the New York Hospital. All the children were native speakers of

TABLE 1

General Design of Mini-Longitudinal Study

Task Measures	Situation: Naturalistic (Group Play)	Situation: Laboratory (Individual)
Production	Spontaneous (2.3)[1] Elicited Speech (2.3)[3] (App. B 56-63)	_____[2] Elicited Speech (App. , p.86-88)
Comprehension	Behavioral (Act-Out) a. meaningful context (2.3) b. arbitrary context (2.3) Verbal (Ans. questions) (App C 90-91)	Behavioral (Act-Out) a. meaningful context (2.5) b. arbitrary context (2.5.1) Verbal (Ans. questions) (App. B p.86-88)
Imitation	Behavioral (Act-Out) (2.3) Verbal (sentence repetition) (2.3)	Verbal (sentence repetition) (2.5.2)

[1]Numbers in parenthesis indicate the sections in which the tasks are described; capital letters indicate the appendices in which more detailed descriptions may be found.

[2]Although the children were free to talk none of the speech was transcribed.

[3]Since these tasks measure children's comprehension of the questions as well as their verbal responses, the same tasks, depending on the type of analysis, may be listed as production or comprehension.

TABLE 2

Characteristics of Individual Subjects

Subject I.D.	Sex	Father's Occupation	IQ[1]	MA[1]	Mean Age at each Assessment Period			
					1	2	3	4
1	M	faculty	154+	4;10	2;4	2;6	2;8	2;11
2	M	physician	126	4;0	2;6	2;8	2;10	3;11
3	M	physician	121	3;10	2;7	2;9	3;0	3;2
4	F	physician	137	4;7	2;7	2;10	3;0	3;2
5	F	industrial designer	134	4;8	2;8	2;10	3;0	3;2
6	F	physician	129+	4;7	2;8	2;10	3;1	3;3
8	F	investment banking	137	5;2	2;10	3;1	3;3	3;5
9	M	physician	113	4;0	3;0	3;2	3;5	3;7
11	F	physician	111	4;5	3;0	3;3	3;5	3;7
12	M	med. practitioner	122	4;10	3;1	3;3	3;5	3;7
15	F	parks dept. employee	110	5;1	3;9	3;11	4;1	4;3
16	F	teacher	148	6;8	3;7	3;9	4;0	4;2
17	F	oral surgeon	108	5;3	3;11	4;1	4;3	4;5
18	M	faculty	132	6;6	4;0	4;2	4;5	4;7
19	M	physician	108	5;5	4;0	4;3	4;5	4;7

[1]Stanford-Binet IQ's were administered beginning in the third assessment period. Testing time is underlined.

English.

Table 2 describes the sample by chronological age at each assessment, their mental age, sex, and father's occupation. Two children were dropped from the data analysis, #10 (female) because frequent illnesses made a regular testing schedule impossible, and #13 (male) because of a hearing loss that was not discovered until the second testing period.

The six youngest children attended their own playgroup twice a week while the two older groups of children attended their own playgroup once a week. At the start of the testing, the youngest group's (A) ages ranged from 2;4 to 2;8; the next oldest group (B) ranged from 2;10 to 3;1; the oldest group (C) ranged from 3;9 to 4;0.

2.3 Naturalistic Setting.

Description. The naturalistic setting (the playroom) was set up as a comfortable well-equipped nursery school. The teacher supervised free play and organized activities suitable for each age group. The room was divided into four separate play areas: a doll play area equipped with standard doll-play material (child's refrigerator, stove, crib, mirror, adult clothing, table, kitchen equipment, etc.); a block area; an arts and craft area; and a water play area. The classroom was equipped with cameras and video equipment which could easily scan and record any activities in the classroom. A complete description of the video and transcribing equipment may be found on pg.35 of the original NIE proposal which is included as Appendix A.

Various game-like procedures were designed by the classroom teacher to assess the child's receptive and productive temporal vocabulary in a play-like situation. In addition, she designed a few tasks to assess the child's memory for temporal events. For example, the teacher initiated conversations at least once a month which attempted to elicit vocabulary in the temporal domain during the group's snack time. Different topics such as "People and ages" ("Who is older, you or your mommy?") and "How do you know when..." ("..to go to bed? ..to go to school? ..it's time for dinner?") were chosen. Table 3 lists the activities classified as Production, by month of study, age group and topic.[2]

Another activity in the classroom attempted to demonstrate the children's comprehension of temporal concepts. The teacher designed scripts for cooking sessions and a playdough making session in which each child was individually asked to perform a task involving two events. For instance, she might say, "Open the salt before you get us a cup from the sink." or "After Johnny fills the cup to the top, you can open the milk carton." Table IV lists the activities classified as Comprehension.

In order to test the children's imitative abilities, a series of games such as "Follow the Leader," and "Simple Simon" were designed. Children took turns imitating a series of events the teacher performed, such as "stand on the chair, put on the hat, clap your hands." To test the children's ability to repeat sentences describing temporal events, the teacher wrote a script from a favorite classroom story book, Caps For Sale. The children then reenacted the story with the teacher giving each line for the child to repeat.

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[2]A copy of the complete classroom procedures written by the classroom teacher is available upon request from Ms. Mary Jo Altom, The Rockefeller University.

TABLE 3

ACTIVITY SCHEDULE FOR PLAYGROUP OBSERVATIONS: PRODUCTION

Month of study	Age	Group I	Age	Group II	Age	Group III
1	2;7	Time Conversation: clocks & watches	3;0	Time conversation: birthdays	3;10	Time Conversation: Counting & ages; birthdays
2	2;8	Time Conv: How do you know when?; recall of playdough activity; Christmas; Christmas recall	3;1	Time Conv: Halloween recall; Christmas	3;11	Time Conv: Thanks-giving recall; When..? Christmas recall; How do you know when..?
3	2;9	Time Conv: clocks; clocks & watches sequential time	3;2	Time Conv: How do you know when..?	4;0	Time Conv: past experiences; seasons; clocks & watches
4	2;10		3;3	Time Conv: Sequential Time	4;1	
5	2;11	Time Conv: Easter recall; people & ages	3;4	Time Conv: people & ages	4;3	Time Conv: people & ages; birthdays & dates
6	3;0	Time Conv: Easter & turn taking; housekeep-ing fantasy	3;5	Time Conv: Easter recall	4;4	Time Conv: Easter recall
7	3;1	Time Questionnaire: (Understanding of Hierarchy of Time)	3;6	Time Conv: How do you know when..? Time Questionnaire: (Understanding of Hierarchy of Time)	4;5	Time Questionnaire: (Understanding of Hierarchy of Time)
8	3;2	Time Conv: future: clocks & watches, ages birthdays	3;7	Time Conv: future, people's ages	4;6	Time Conv: future, people's ages

TABLE 4

ACTIVITY SCHEDULE FOR PLAYGROUP OBSERVATIONS: COMPREHENSION

Month of study	Age	Group I	Age	Group II	Age	Group III
1	2;7	Comprehension of Temporal Concepts Task (fruit salad)	3;0		3;10	
2	2;8	Comprehension of Temporal Concepts Task (making playdough)	3;1		3;11	
3	2;9	Comprehension of Temporal Concepts Task (pancakes)	3;2	Comprehension of Temporal Concepts Task (pancake)	4;0	Comprehension of Temporal Concepts Task (pancake)
4	2;10		3;3	Comprehension of Temporal Concepts Task (cook & clean up)	4;1	Comprehension of Temporal Concepts Task (cook & clean up)
5	2;11		3;4	Comprehension of Temporal Concepts Task (playdough)	4;3	Comprehension of Temporal Concepts Task (making valentines)
6						
7						
8						

TABLE 5

ACTIVITY SCHEDULE FOR PLAYGROUP OBSERVATIONS: IMITATION

Month of study	Age	Group I	Age	Group II	Age	Group III
1						
2						
3						
4	2;10	Verbal Imitation Task (Caps for Sale)	3;3	Verbal Imitation Task (Caps for Sale)	4;1	Verbal Imitation Task (Caps for Sale)
5	2;11	Non-Verbal Sequential Imitation Task (Follow the Leader)	3;4	Non-Verbal Sequential Imitation Task (Follow the Leader)	4;3	Non-Verbal Sequential Imitation Task (Follow the Leader)
6						
7						
8						

For example, the teacher would say, "Johnny, you say, 'Let's take his caps while he's sleeping.'" Table 5 lists the activities classified as Imitation.

Results. Once a month the children's conversations were videotaped and subsequently transcribed. In total 21,000 lines of transcription are now available for word records and sentence analysis. Thus far, one graduate student from Yeshiva University, as part of her Master's thesis, has conducted a word search for temporal terms.[3] She searched a total of 12 transcripts (5 for group B and 7 for group C).[4] Tables 6 and 7 present a summary of frequency of the children's utterances and the frequency of spontaneous usage of the following temporal terms: before, after, when, then, first, until, while, and next. As the tables reveal, except for one child, the percent time words of total number of words spoken was less than 2% for each child. The one exception, child #10, actually spoke very little and her percentage may be an artifact of the small number of sessions she was present (4) and the low frequency of her utterances. She only spoke 197 words during four sessions. On the average, temporal terms were used less than 1% of the time for the sample transcribed. Approximately 2% of the teacher's words were temporal terms. Since the conversations transcribed were designed to elicit temporal terms, we were surprised at the children's low frequency. However, at present we have no other data with which to compare our frequencies. We do not even know whether the teach-

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[3] The transcripts are presently being used to search for the children's development of modal verbs.

[4] Group A was not searched because preliminary analysis revealed an even lesser frequency of spontaneous usage of temporal terms.

er's lack of usage of temporal terms is comparable for preschool situations.

The next table presents the frequencies for individual temporal terms (see Table 8). The most frequently used temporal connectives were when and then. Surprisingly, before and after, the connectives most frequently heard in the laboratory situation, were among the terms least used. Thus, children tend to produce few temporal terms although the laboratory data indicate that they can comprehend much more. When was used most frequently to indicate a specific point on time ("When snack is over"). Of the 50 uses of when, 12 were in the form of a question ("When will it stick?"). Then was used most frequently to seriate events (for example, "...then go to your bed, and then clean your teeth"). Sometimes it appeared as though then was used in place of afterwards or after as in the example, "Once I didn't have it [like it] and then I tasted it, and I loved it," meaning "after I tasted it, I liked it."

The word next was used frequently by the children in Group C and although there were only three cases in which it was used by the children in the younger group it was used incorrectly in two of the cases. In one instance, a child said, "I'm next to you, John." Although out of context the sentence sounds perfectly correct (I'm standing next to you John...), it was used to mean "I'm after you (to use the paint) John..." Another child used next with a past tense marker ("She's five and six. She had her next birthday."). (Appendix B lists the utterances using the searched temporal terms.)

Although the children's productions of time words were low,

TABLE 6

Summary of Distribution of Utterances and Searched Temporal Terms[1]

Group B

Speaker	Number of Sessions Present	Number of Words Spoken	Average % of Total Speech	Number of Temporal Terms Spoken	% of Temporal Terms of Child's Speech
8F	5	898	7.1%	7	.7%
9M	5	1427	11.8%	6	.4%
10F	4	197	3.7	6	4.6%
11F	6	787	5.5%	5	.6%
12M	6	2740	14.9%	17	.6%
13M	5	2840	10.9%	2	0%
Teacher	6	7578	51.0%	153	2.0%

[1] Based on 6 sessions. Searched Terms = before, after, next, then, when, while, until, first.

[2] Percent of Total Speech by each child averaged across sessions present.

[3] Number of temporal terms spoken by each child compared to each child's total number of words spoken.

TABLE 7

Summary of Distribution of Utterances and Searched Temporal Terms[1]

Group C

Speaker	Number of Sessions Present	Number of Words Spoken	Average[2] % of Total Speech	Number of Temporal Terms Spoken	% of Temporal Terms of Child's Speech[3]
15F	5	1071	14%	9	.8%
16F	7	3986	16%	26	.7%
17F	4	1533	10%	8	.5%
18M	6	1672	11%	15	.9%
19M	6	1814	10%	22	1.2%
Teacher	7	12503	54%	209	1.7%

[1] Based on 7 sessions. Searched Terms = before, after, next, then, when, while, until, first.

[2] Percent of Total Speech by each child averaged across sessions present.

[3] Number of temporal terms spoken by each child compared to each child's total number of words spoken.

TABLE 8

Frequency Distribution of Spontaneous Use of Temporal Terms for Each Child across Situations

Subject I.D. Number	Before	After	When	Then	Next	While	Until	First	Total
8F			2	3				2	7
9M			3	5				1	9
10F			1	4				1	6
11F	1		1	2	1				5
12M	1		9	3	2			3	17
13M		1	1						2
Total Group B	2	1	16	17	3	0	0	7	46
15F		1	7		1				9
16F		1	6	7	8	1		3	26
17F	2		3	2		1			8
18M		1	10	1			1	2	15
19M		1	8	5	6			2	22
Total Group C	2	4	34	15	15	2	1	7	80
Total	4	5	50	32	18	2	1	14	126

there is no reason to conclude that their conceptual understanding of temporal order was also low. First of all our search did not pick up all those instances in which children intended a temporal sequence but did not use a term to connect the events ("I eat my breakfast to go to school.") Data from our sentence repetition task indicated that it was not uncommon for children to omit a temporal connective in repeating a sentence describing two events. (See section 2.5.2.) Secondly, although all the conversations were intended to elicit conversations about temporal events, they all took place under static conditions -- snack time in the playroom. Thus, for children to talk about temporal events would have forced them to recall events from the past or talk about future events without the help of a familiar framework or the presence of concrete cues. Thus, temporal tenses were very connected to present ideas, such a turn taking, and these events did not occur that frequently at snack time. Thus, we hoped that in the laboratory setting where minimal emphasis was placed on the child's ability to recall past events or discuss future events would give us a clearer picture of, at least, the child's ability to comprehend temporal terms.

2.4 Procedures in Laboratory Setting.

The data from the longitudinal sample was collected during individual interviews conducted in a nearby child's experimental room. This testing room was carpeted in a red color and was furnished with a child's sized table and chairs. Prior to the first session, the interviewer spent considerable time in the classroom getting acquainted with the children and waiting until the children felt comfortable enough to leave the classroom with her. Time

was also spent talking and reading stories in the laboratory setting to the children in the youngest group. This was continued until the children felt comfortable. The two older groups had no difficulty in adapting to the laboratory situation. Interviews varied from about 5 minutes to 20 minutes depending on the child's attention span and his individualized assessment schedule. The interviewer took breaks when the child seemed tired or bored. A typical testing schedule for a hypothetical child is illustrated in Table 9. Interviews included tests not only of temporal terms but also color and spatial terms.[5]

Detailed descriptions of the laboratory tasks can be found in section 2.5: Assessment Battery.

[5] Dr. Elsa Bartlett studied the acquisition of color and spatial terms within the same longitudinal framework. Comprehension and production tasks were given repeatedly during the seven month study period in both the classroom and laboratory settings. These tasks were administered by the classroom teacher and research assistant who administered the temporal tasks. Dr. Bartlett's tasks were interspersed with the temporal tasks to minimize boredom of repeated testing with only temporal tasks.

TABLE 9

ASSESSMENT SCHEDULE FOR TYPICAL CHILD

Week 1	Bartlett Spatial Imitation of Two Motor Sequences: forward I
Week 2	Bartlett Color Imitation of Two Motor Sequences: backward I Bartlett Spatial Act-out Sentences I : imperative form; same verb
Week 3	Act-out Sentences I imperative form, same verb Bartlett Act-out Sentences I imperative form, same verb Bartlett Temporal Duration: Identification of long and short Intervals I
Week 4	Act-out Sentences I : declarative form; different verb Bartlett Act-out Sentences I declarative form; different verb Bartlett Act-out Sentences I Logical/Illogical
Week 5	Bartlett Act-out Sentences I Logical/Illogical
Week 6	Metalinguistic Task: Word Associations to Temporal Concepts I Bartlett Number Concepts I
Week 7	Bartlett Comprehension of Questions beginning When/Where

2.5 Assessment Battery

The following is a summary description of all the temporal tasks administered in the laboratory setting. The type of assessments can be divided into the following categories: Sentence Comprehension (2.5.1) In each of these tasks the children displayed their understanding of complex temporal sentences by acting out the events described in the sentence. Imitation. (2.5.2) In this task, children displayed their memory for complex temporal sentences by repeating model sentences. In each of these sections, the purpose of the tasks, their description and specific results are discussed. In addition copies of the tests can be found in Appendix C .[6]

2.5.1 Sentence Comprehension

Act-Out: Imperative Sentences

Purpose. Many researchers (see for example Bryant, 1973) argue that the errors children make in cognitive tasks may be attributable to their inability to remember the various components of the tasks. One of the problems very young children may have in acting out complex sentences is their inability to remember both clauses. Thus, we devised a series of act-out sentences which would place a minimal load on the child's memory. In addition, because of the theoretical controversy concerning the development of temporal connectives (Clark's [1971] semantic feature hypothesis vs. Amidon and Carey's [1973] syntactic complexity hypothesis) we decided to devise one set of sentences in the imperative mood, and one set in the declarative. The sentences devised for the act-out imperative put the least amount of stress on the child's memory and at the same time allowed us to

[6] In addition, several tasks designed to elicit speech and at the same time test the child's verbal comprehension of temporal questions were given. These tasks included a test of the children's ability to answer questions beginning with "when" and "where," and the extent of their categorical organization of temporal terms. A copy of each of the tests as they were actually administered to the child may be found in Appendix C. The results of these tests have not been analyzed.

compare the difficulty in errors between imperative and declarative sentences.

Description. Each child was asked to act out a series of complex sentences conjoined by the following temporal connectives: before, after, next, and then, but first, while, until,[7] when,[8] and and.[8] All sentences were in the imperative mood and the verb in both clauses was always the same. During the first two assessment periods every sentence used the verb pick up. The sentences were of the form: "Pick up X before you pick up Y" where X and Y were names of two familiar toys. During the third and fourth assessment periods other action verbs were substituted for pick up (for example, kiss, roll, pat, hit, smell, drop, walk, throw, touch, wave, eat). However, the two verbs within a sentence still remained the same. The connectives were tested twice at two consecutive sessions at each of the four assessment periods. Before the interviewer read the sentences, she placed two toys in front of the child. The position of the toy in relation to the child's left or right hand was counterbalanced with the restriction that no object (toy) which was mentioned first would be placed in any one position more than two times in a row. After a child acted out a sentence the interviewer recorded the child's actions. During the third assessment period the connectives next and and then were dropped from the battery to shorten the test. During the fourth assessment each child was tested on only those connectives on which he had not reached ceiling performance on the previous two assessments. This was done because children had become bored with the task. (See pages 65-71 of Appendix C for a copy of the test forms.)

Results. The percentage of correct responses to each of the connectives was computed for the entire group for each of the assessment periods (see Table 10). As one can see the overall performance of the group improved from 61% to 77% over the 4 assessment periods. During the first assessment period the forward

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[7]Although until was administered at the first three assessments, the children's responses were difficult to score. Their responses to until resembled both before and while. While such responses are partially correct we felt our act-out task was not tapping the nuances between before and until. Therefore, children's responses to until were omitted from all analyses.

[8]When was omitted from the analyses because adult participants in an informal study gave all possible responses (FCF, SCF, and simultaneous) to test sentences with when. And was included in the study as a measure of the child's ability to follow the instructions, remember the sentences, and to see whether, given sentence structure which does not explicitly imply a temporal order, children would use an order-of-mention response. The data indicated that at the first assessment children responded 30% order-of-mention; 17% reversal and 53% simultaneous. This distribution remained about the same across the other three assessments. Such a finding lends some support to the reliability of our measure, namely that repeated testing did not unduly influence the children's responses.

TABLE 10

Percentage of Correct Responses to Act-Out Imperative Sentences by Connective and Assessment Period

(N=15)

Imperative % Correct
% Correct Responses x Connective and Assessment Period

Connective/ Assessment	1	2	3	4	Mean
A next B	87	90	100	93	93
A and then B	73	87	97	93	88
B but first A	70	90	83	93	84
After A, B	73	60	77	87	74
A before B	77	77	90	80	81
B after A	37	30	43	50	40
Before B, A	37	50	70	60	54
A while B	37	53	57	63	53
Mean	61	67	77	77	71
Mean (before & after only)	56	54	70	69	

sentences (next, and then, A after B, A before B) were the easiest whereas the backward sentences (Before B, A and B after A) were the most difficult. However, children's performance on the coordinating conjunction B but first A was equal to that of the forward sentences. During the second assessment period children's performance on B but first A excelled that of the two forward sentences A before B, and After A, B. Comparison of the children's performance on B but first A with the forward sentences during the first and second assessment periods indicates that how children respond to these sentences cannot be attributed entirely to a first-clause-first strategy or an inability to remember events in the reverse from which they are mentioned.

Since the results from but first were not predicted from previous research we wanted to examine the various response patterns that individual children gave to the various connectives. Each child's response was classified into one of the following categories: (1) First-clause-first (FCF) -- the child acted-out the first clause spoken first, and the second clause spoken second; (2) Second-clause-first -- the child acted-out the second clause spoken first, and the first clause spoken second; (3) Simultaneous -- the child acted-out both events at the same time; (4) Other -- the child omitted one of the clauses, did not respond or his response was unscoreable. Tables 11-A, 11-B, 11-C, and 11-D present the number of correct responses for each child for each sentence construction as well as various response patterns that individual children used (column sums) and the various response strategies used by all the children for each connective (row sums).

First of all, the tables indicate that young children do not rely almost exclusively on a first-clause-first strategy. Clark's semantic feature hypothesis implies that children will use an order-of-mention response when they do not understand the meaning of a temporal connective (Clark, 1971). During the first assessment period, only 7 of the 15 children used a first-clause-first strategy more than 50% of the time. This proportion stayed the same throughout the 4 assessment periods despite the fact that the children's performance improved from 61% to 77% correct responses during the 7 month interval.

The above results were the first in a series which led us to question whether an order-of-mention response is used by young children when they are unfamiliar with a temporal connective. An alternative hypothesis is that children who use an order-of-mention response know quite a bit about temporal ordering of the time concept but are merely unfamiliar with its linguistic expressions -- that is, with some of the syntactic rules used to indicate temporal ordering in English. This idea was pursued further during the third assessment period when we tested children with completely unfamiliar temporal connectives.

Act-Out: Sentences with Unfamiliar Connectives

Purpose. This test was designed to answer the following question: Do young children, regardless of temporal connective

TABLE 11-A

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT IMPERATIVE SENTENCES AT ASSESSMENT I

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	4	9	11	3	12	15	16	18	1	2	6	8	5	17	19	Total Response Types %FCF[1]	%SCF	%SIM	%OTH
A next B[2]	2	2	1	2	2	2	2	2	2	1	1	1	2	2	2	87[3]	13	0	0
A before B	1	1	1	2	2	1	1	1	2	2	2	1	2	2	2	77	23	0	0
After A, B	1	1	2	1	2	1	2	1	1	2	1	2	2	2	1	73	17	10	0
A and then B	1	0	1	2	2	0	1	1	2	2	2	2	2	2	2	73	17	10	0
B but first A	0	2	1	1	0	1	2	2	2	1	1	2	2	2	2	20	70	10	0
B after A	0	0	1	0	0	0	0	0	0	2	1	2	1	2	2	43	37	20	0
Before B, A	1	1	0	0	0	2	1	0	0	1	2	1	0	1	1	57	37	3	3
A while B	1	0	0	0	0	2	0	2	2	0	1	0	1	0	2	43	20	37	0
correct	7	7	7	8	8	9	9	9	11	11	11	11	12	13	14				
% correct	44	44	44	50	50	56	56	56	69	69	69	69	75	81	88				
% FCF	38	38	63	81	100	25	63	56	69	63	50	50	81	63	50				
% SCF	19	50	38	13	0	31	38	19	19	38	44	44	19	38	38				
% SIM	44	6	0	6	0	44	0	25	13	0	6	6	0	0	13				
% OTH	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

TABLE 11-B

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT IMPERATIVE SENTENCES AT ASSESSMENT II

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	4	1	3	2	6	12	18	5	11	15	16	19	9	8	17	Total Response Types %FCF[1]	%SCF	%SIM	%OTH
A next B[2]	1	2	2	1	1	1	2	2	2	2	2	2	2	2	2	90[3]	7	3	0
B but first A	1	2	2	2	2	2	2	2	2	0	2	2	2	2	2	10	90	0	0
A and then B	2	2	0	1	1	2	2	2	2	2	2	2	2	2	2	87	10	3	0
A before B	0	0	2	1	2	2	2	1	2	1	2	2	2	2	2	77	17	3	3
After A, B	1	1	1	0	1	2	1	2	2	1	0	2	2	1	1	60	23	17	0
A while B	1	0	0	2	2	0	1	2	0	2	1	0	1	2	2	33	13	53	0
Before B, A	2	1	1	1	1	0	0	0	0	2	1	1	1	2	2	33	50	3	3
B after A	0	1	1	1	0	1	0	0	1	1	1	0	1	1	1	50	33	17	0
correct	8	9	9	10	10	10	10	11	11	11	11	11	13	14	14				
% correct	50	56	56	63	63	63	63	69	69	69	69	69	81	88	88				
% FCF	31	56	75	31	56	75	75	50	75	25	56	75	69	50	44				
% SCF	50	38	25	44	25	25	19	19	25	38	38	25	25	31	31				
% SIM	13	6	0	25	13	0	6	31	0	38	6	0	6	0	25				
% OTH	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

TABLE 11-C

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT IMPERATIVE SENTENCES AT ASSESSMENT III

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	3	5	6	15	16	4	9	12	18	1	8	11	2	17	19	Total Response Types %FCF[1]	%SCF	%SIM	%OTH
A next B *	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	100[3]	0	0	0
A and then B *	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	97	0	3	0
A before B	2	2	2	2	2	2	2	1	2	2	1	2	1	2	2	90	7	3	0
B but first A	1	0	2	2	2	1	2	2	2	2	1	2	2	2	2	0	83	17	0
After A, B	1	2	1	1	2	2	2	1	1	1	1	2	2	2	2	77	20	3	0
Before B, A	2	1	0	1	0	2	2	2	2	2	2	1	2	1	1	30	70	0	0
A while B	0	2	2	2	1	0	0	0	1	1	2	1	1	2	2	13	30	57	0
B after A	0	0	0	0	0	1	0	2	0	1	2	1	2	2	2	53	43	3	0
correct	10	11	11	11	11	12	12	12	12	13	13	13	14	15	15				
% correct	63	69	69	69	69	75	75	75	75	81	81	81	88	94	94				
% FCF	56	73	81	69	69	69	38	56	56	50	38	63	44	56	56				
% SCF	38	6	13	25	19	31	63	19	38	44	44	31	44	31	31				
% SIM	6	31	6	6	13	0	0	25	6	6	19	6	6	13	13				
% OTH	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

TABLE 11-D

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT IMPERATIVE SENTENCES AT ASSESSMENT IV

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	4	19	3	15	8	2	6	12	9	16	11	17	18	5	1	Total Response Types %FCF[1]	%SCF	%SIM	%OTH
A next B	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	93	3	3	0
A and then B	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	93	7	0	0
B but first A	2	2	1	2	2	2	2	2	1	2	2	2	2	2	2	7	93	0	0
After A, B	1	1	1	2	2	1	2	2	2	2	2	2	2	2	2	87	13	0	0
A before B	1	0	2	1	2	2	1	1	2	2	2	2	2	2	2	80	17	3	0
A while B	1	1	1	2	0	1	2	1	0	1	1	2	2	2	2	13	20	63	3
Before B, A	1	1	0	1	2	1	1	1	2	1	1	1	1	2	2	33	60	7	0
B after A	1	0	2	0	0	1	0	1	2	1	2	1	1	1	2	47	50	3	0
correct	8	9	11	11	12	12	12	12	13	13	14	14	14	15	16				
% correct	50	56	69	69	75	75	75	75	81	81	88	88	88	94	100				
% FCF	50	38	63	50	63	63	63	50	63	63	56	63	63	56	50				
% SCF	38	50	25	31	38	31	19	38	38	31	38	35	25	31	38				
% SIM	6	13	13	19	0	6	19	13	0	6	6	13	13	13	13				
% OTH	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

act-out sentences in the order in which they are mentioned? If a first-clause-first strategy indicates a response bias on part of the child then an act-out task that contains an unfamiliar (meaningless) connective should elicit a consistent pattern of responses.

Description. During the third assessment period, without any special instructions, a series of nonsense connectives were embedded into the regular act-out imperative test battery. The sentences were syntactically identical to the act-out imperative sentences: there were eight sentences of the form A bittler B; Bittler A, B; Alshem A, B; A alshem B. Each child heard 4 of these sentences one week apart. (See pages 73-74 of Appendix C for a copy of the test forms.)

Results. The children's responses were scored similarly to the act-out imperative (see p.24 for more detail): order-of-mention, reversals, simultaneous and other. If, as Clark suggested, young children use a first-clause-first strategy when they do not understand a temporal connective, then meaningless connectives like bittler and alshem should elicit a consistent pattern of first-clause-first responses.

Table 12 presents the response strategies for each of the nonsense connectives, as well as to before and after during the first and third assessment periods for each group. As the table shows, responses to the nonsense connectives were divided among the three types of temporal orderings. The first-clause-first response occurred 44% of the time, the second-clause-first response occurred 35% of the time, and 21% of the time the two actions were performed simultaneously. When we compare this distribution of responses to those the children made to before and after during their first assessment period, it becomes apparent that children had already formed some hypotheses about before and after, at least for sentences of the type A before B, After A, B, and Before B, A. For example, they knew that a simultaneous response was not appropriate for these sentences. The striking result, however, is the similarity in response patterns between the nonsense connectives and B after A at the first assessment. This result does not support the idea that children use a first-clause-first strategy when they do not comprehend a temporal connective nor does it support the notion that they overgeneralize before to mean after. What is most striking about the B after A data on the first assessment is the high percent of simultaneous responses. It suggests that B after A was treated like a nonsense connective; when children don't know what to make of a temporal connective, they generate a 45-35-20 distribution of responses.

The variety of responses to the nonsense connectives was a little bewildering. These children had been tested almost every other week with some form of a temporal comprehension act-out task. We expected that they would use an order-of-mention response predominantly. After all, that had been the response they had given most of the time, and for the majority of the test sentences it had been the correct response. Yet, the data just presented indicate that the children used all possible

TABLE 12

Classification of Responses to Meaningful and Nonsense Connective[a] by Assessment Percent

Connective	Response Patterns							
	Order-of-Mention		Reveral		Simultaneous		Other	
	Asses.I	Asses.III	Asse.I	Asses.III	Asses.I	Asses.III	Asses.I	Asses.III
	%	%	%	%	%	%	%	%
A before B	77	90	23	7	0	0	0	3
After A, B	73	77	20	20	7	3	0	0
Before B, A	57	30	37	70	3	0	3	0
B after A	43	53	37	43	20	3	0	0
Total	63	63	29	35	8	2	1	1
"Nonsense"	--	44	--	35	--	21	0	0
And	30	23	17	27	53	50	0	0

[a] N=15
Mean Age Assessment I = 3;1
Mean Age Assessment III = 3;6

temporal orderings. Perhaps their thorough familiarity with temporal connective tasks led them to develop some complex and unexpected hypotheses about the nonsense connectives. Therefore, we replicated this study with a new sample. For a summary of this study see Appendix D.

Act-Out: Declarative Sentences

Purpose. Much of the theoretical work on the development of temporal connectives is derived from Clark (1971). She concluded that the differential difficulty between before and after could be explained by a semantic markedness hypothesis. The sentences she used were all act-out declarative sentences. Preliminary results from our imperative sentences indicated that we were not replicating Clark's findings. Our children did not rely exclusively on an order-of-mention response. Since we did not know whether this was due to our procedures or our sample we felt it necessary to replicate Clark's study as much as possible. If the results from our sample in the declarative sentences were similar to Clark's then we could conclude that our sample is representative of hers, and differences between our test sentences and hers would have to be attributed to our procedures.

Description. The test sentences were adapted from Clark (1971). Each declarative sentence had a subject (boy or girl) in the first clause, which was pronominalized in the second clause; each clause contained one of six different action verbs (pat, kick, throw, jump, kiss, and sit) and each clause contained one of eight different objects (toys the children could name, such as mouse, ball, rock, gate, box, bird, dog, and horse). Verbs and objects were paired to form a total of 32 clauses, and these clauses were combined with the eight temporal connectives to form two sets of eight sentences. One set was presented at each testing session. (See pages 80 to 86 in Appendix C for a copy of the test form.)

Results. The percentage of correct responses to each of the connectives was computed for the entire group for each of the assessment periods. Table 13 gives the percent correct for the declarative sentences at each assessment, (For the reader's convenience numbers in parentheses are those shown in Table 7 for imperative sentences) and Tables 14, A, B, C, D describe the response patterns for each child and connective at each assessment period. Although connectives which preserve order-of-mention (A before B, After A, B) are easier than those which do not (Before B, B), there were no differences between before and after. The pattern of responses to each of the connectives for the declarative sentences is unclear. While children showed no change in their performance with sentences of the type A before B, sentences of the type After A, B fluctuated between 77% correct at the first assessment and only 60% correct at the last assessment period. Although the connective B after A appears to give a clear developmental trend (27% correct at the first assessment and only 60% correct at the last assessment), nonetheless it does not replicate other studies. On two of the four assessments (assessments III and IV) the construction B after A is easier than Before B, A. Further,

TABLE 13

Percentage of Correct Responses to Act-Out Declarative Sentences by Connective on Assessment Period

(N=15)

Connective	Assessment I	II	III	IV	Mean
A before B	70(77)[1]	70(77)	72(90)	73(80)	71(81)
After A, B	77(73)	60(60)	70(77)	60(87)	67(74)
Before B, A	43(37)	63(50)	45(70)	37(60)	47(54)
B after A	27(37)	30(50)	57(43)	67(50)	45(40)
B but first A		87(90)	79(83)	80(93)	82(84)
A next B		70(90)	60(100)	73(93)	68(93)
A and then B		83(87)	77(97)	83(93)	81(88)
A while B		57(53)	52(57)	50(63)	53(53)
Mean	54(56)	65(67)	64(77)	65(77)	62(71)
Mean (before & after only)	54(56)	56(54)	61(70)	59(69)	

[1]Numbers in parentheses are percent correct for imperative sentences. See Table 10.

TABLE 14-A

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT DECLARATIVE SENTENCES AT ASSESSMENT I

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	9	5	1	3	6	8	12	16	2	4	11	17	18	15	19	Total Response Types %FCF[1]	%SCF	%SIM	%OTH
After A, B	0	1	1	2	2	2	1	2	1	2	1	1	2	2	1	77	10	0	13
A before B	0	1	2	2	1	1	2	2	1	2	2	1	2	2	2	70	13	0	17
Before B, A	1	0	1	0	1	0	1	0	1	1	1	2	1	1	2	50	43	0	3
B after A	0	0	0	0	0	1	0	0	2	0	1	1	0	1	2	63	27	0	10
correct	1	2	4	4	4	4	4	4	5	5	5	5	5	6	7				
% correct	13	25	50	50	50	50	50	50	63	63	63	63	63	75	88				
% FCF	25	75	63	88	75	63	75	100	38	88	63	75	88	75	38				
% SCF	63	13	13	0	13	13	13	0	50	13	38	0	13	25	50				
% SIM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
% OTH	13	13	25	13	13	25	13	0	13	0	0	25	0	0	13				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

TABLE 14-B

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT DECLARATIVE SENTENCES AT ASSESSMENT II

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	3	2	4	6	9	15	19	1	11	12	16	18	5	8	17	Total Response Types %FCF[1]	%SCF	%SIM	%OT
B but first A	2	1	2	1	1	2	1	2	2	2	2	2	2	2	2	7	87	0	7
A and then B	1	2	2	1	2	2	1	1	2	2	2	1	2	2	2	83	10	0	7
A before B	1	1	1	1	0	1	2	0	2	2	2	2	2	2	2	70	17	0	13
A next B	0	0	0	2	2	1	2	2	1	2	2	2	2	1	2	70	23	0	7
Before B, A	1	1	2	2	2	0	0	2	0	1	0	2	2	2	2	20	63	7	10
After A, B	0	0	1	1	1	2	1	1	2	1	2	1	2	1	2	60	30	0	10
A while B	0	2	0	0	1	1	1	1	2	1	1	2	1	2	2	33	3	57	7
B after A	0	2	1	1	0	0	1	1	0	0	0	1	0	1	2	60	30	0	10
correct	5	9	9	9	9	9	9	10	11	11	11	12	13	13	16				
% correct	31	56	56	56	56	56	56	63	69	69	69	75	81	81	100				
% FCF	31	19	31	50	56	63	56	38	56	69	81	44	69	50	50				
% SCF	31	44	50	44	38	19	25	44	19	25	13	38	25	44	38				
% SIM	0	13	0	0	6	6	6	6	25	6	6	13	6	0	0				
% OTH	38	25	19	6	0	13	13	13	0	0	0	6	0	6	13				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

percent correct is underlined

TABLE 14-C

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT DECLARATIVE SENTENCES AT ASSESSMENT III

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	3	2	4	12	6*	9	5	15	16	8	11	18	19	1	17	Total Response Types %FCF[1]	%SCF	%SIM	%OT
B <u>but first</u> A	0	1	2	1	1*	2	2	2	1	2	2	2	1	2	2	17	<u>79</u>	0	3
A <u>and then</u> B	1	1	1	1	2	0	2	1	2	2	2	2	2	2	2	<u>77</u>	13	0	10
A <u>before</u> B	1	1	1	1	1*	1	1	1	2	1	2	2	2	2	2	<u>72</u>	21	0	7
<u>After</u> A, B	1	0	1	2	2	2	1	1	2	1	1	2	1	2	2	<u>70</u>	13	0	17
A <u>next</u> B	1	1	0	1	0*	2	1	1	2	0	1	2	2	2	2	<u>62</u>	17	0	21
B <u>after</u> A	1	2	1	1	0	1	1	0	0	2	2	0	2	2	2	37	<u>57</u>	0	7
A <u>while</u> B	0	1	0	0	0*	0	2	2	0	2	2	1	1	2	2	27	13	<u>50</u>	7
<u>Before</u> B, A	0	0	1	1	1*	1	0	2	1	1	0	1	1	2	2	34	<u>45</u>	0	21
correct	5	7	7	8	6	9	10	10	10	11	12	12	12	16	16				
% correct	31	44	44	50	55	56	63	63	63	69	75	75	75	100	100				
% FCF	56	25	31	56	82	44	44	25	81	25	50	50	56	50	50				
% SCF	19	19	56	31	18	56	19	38	19	44	38	38	31	38	38				
% SIM	0	6	0	0	0	0	13	13	0	13	13	13	6	13	13				
% OTH	25	50	13	13	0	0	25	25	0	19	0	0	0	0	0				

* Subject #6 was absent for an extended period and did not receive 2 testings of starred connectives.

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

TABLE 14-D

SUMMARY OF SUBJECTS' RESPONSES TO ACT-OUT DECLARATIVE SENTENCES AT ASSESSMENT IV

Subject x Temporal Connective x Response Type

Number of Correct Responses by Connective and Subject
(N = 15)

Connective / Subject I.D.	9	4	3	5	6	15	19	2	11	16	8	12	18	1	17	Total Response Types: %FCF[1]	%SCF	%SIM	%OT
A and then B	2	0	1	2	2	1	2	1	2	2	2	2	2	2	2	83	7	0	10
B but first A	1	1	1	2	1	2	0	2	2	2	2	2	2	2	2	10	80	0	10
A next B	0	1	1	1	2	1	2	2	1	2	2	1	2	2	2	73	17	0	13
A before B	0	1	2	2	2	1	2	0	1	2	1	2	2	2	2	73	17	0	10
B after A	1	1	0	0	1	2	2	2	2	1	2	1	1	2	2	30	67	0	3
After A, B	1	2	1	0	1	0	1	1	1	2	0	2	2	2	2	60	37	0	3
A while B	0	0	1	1	0	2	0	0	2	1	2	2	1	1	2	33	13	50	3
Before B, A	0	0	0	0	0	0	0	2	0	0	2	1	2	2	2	63	37	0	0
correct	5	6	7	8	9	9	9	10	11	12	13	13	14	15	16				
% correct	31	38	44	50	56	56	56	63	69	75	81	81	88	94	100				
% FCF	50	56	56	63	75	31	69	25	44	50	31	56	63	56	50				
% SCF	38	25	25	25	25	31	19	63	44	31	56	31	31	38	38				
% SIM	0	0	6	6	0	13	0	0	13	19	13	13	6	6	13				
% OTH	13	19	13	6	0	25	13	13	0	0	0	0	0	0	0				

[1] FCF = child acted out first clause spoken first; SCF = child acted out second clause spoken first; SIM = the child acted out the two events simultaneously; OTH = the child omitted one action, made no response or the action was unscorable.

[2] A = the first event in time; B = the second event in time.

[3] percent correct is underlined

the construction Before B, A shows no developmental trend. Performance at assessments I, III, and IV were about the same whereas on assessment II children performed surprisingly well.

There may be several explanations for the fact that the data for the imperative sentences showed an orderly developmental trend, and replicated Clark's general trends, while the declarative sentences did not. First, Tables 14, A, B, C, D indicate that children made an average of 10% errors of omissions on the declarative sentences while there were almost no omissions on the imperative sentences. (See Tables 11, ABCD). Either the sentences were too long, or the actions within the clauses too complicated. Secondly, the toys (boy doll, girl doll, dog, horse, etc.) were such a novelty from the tedious imperative sentences (Pick up X before you pick up Y) that the children in our sample became much more interested in playing with the dolls and objects than in acting-out the sentence. Their motivation for acting-out the sentences was very low. Thirdly, since each clause contained its own verb and object, the young children may have perceived a temporal order between the two clauses which was not implied by the temporal connective. For example, in the sentence "Before the girl sat on the gate, she threw the ball" children may have acted-out the sentence correctly not because they knew the meaning of before when spoken in the initial position of a sentence, but because it made sense to them to: "first throw a ball, then sit down." The data from our "logical-illogical" sentence tasks (see next section) show that very young children will act-out sentences according to what they interpret as logical order and ignore an order indicated by the temporal connective. This will occur even in cases where the child knows the meaning of the connective well.

Since we were confused by the number of omissions in the declarative sentences (Clark reported no omissions) and the lack of a developmental trend, we decided to redo the study with a new sample. It also provided us with the opportunity of replicating on the same set of children the differences in results found between Clark (1971) and Amidon and Carey (1973). (See Section 3. for a discussion of this study.)

Act-Out: Logical and Illogical Sequences

Purpose. Clark (1971) used data obtained from young children's ability to act-out two events in declarative sentences as empirical support for her semantic feature hypothesis. Subsequent studies, whether arguing for or against the semantic feature hypothesis (see for example, Bever, 1970; Carey and Amidon, 1973; Johnson, 1975) used similar sentences; each sentence contained two clauses; the order of events in the sentence could only be determined from the meaning of the connective and its position (beginning or middle) within a sentence. The temporal relation between the two events was arbitrary. This is in direct contrast to how children might hear these sentences used in their everyday environment. (Contrast "Put on your socks before you put on your shoes" with "The boy patted the dog before he jumped over the fence!")

Since previous studies used sentences which expressed arbitrary relations we wondered to what extent Clark's conclusion that children will use an order-of-mention response when they do not understand a temporal adverbial reflect the artificial orderings in her sentences. Data from the studies with unfamiliar connectives already indicated that children use an order-of-mention strategy when they already seem to have some rudimentary mastery of time concepts. Thus we propose that young children rely on their conception of how two events are ordered and that the order in which two events are spoken is less important than the child's intuitions of how he feels they should occur.

Description. The syntactic form of each of the sentences was identical to the sentences used in the declarative sentences. The task was given during the first, third and fourth assessment periods and the following connectives were used: A before B, Before B, A, After A, B, B after A, and then, but first, and and. The sentences were given during two sessions. At each session the child heard 8 sentences, 4 in which the relation between the two events was "logical" and 4 in which the order between the two events was "illogical" (or silly). The relations used during the first assessment period were: (1) opening a water pitcher, giving a doll a drink; (2) putting on a doll's undershirt, putting on a blouse; (3) giving a doll a bath, drying a doll; (4) opening a box of raisins, feeding a raisin to the doll; (5) putting on a doll's socks, putting on a doll's shoes; (6) putting toothpaste on toothbrush, brushing doll's teeth. At assessment periods 3 and 4 the following relations were used: (1) peel a banana, feed banana to doll; (2) put dress on doll, put coat on doll; (3) put cereal on spoon, feed cereal to doll; (4) wash dobl's hands, put on doll's mittens; (5) crack shell on peanut, feed peanut to doll; (6) give doll a bath, dry doll; (7) put on doll's shoes, put on doll's boots; (8) cook corn, feed corn to doll.

For situations in which it was appropriate, the child was supplied with objects of different sizes so that it was physically possible to act-out an illogical order. For example, for the relation "socks-shoes," there were small sized doll's socks, and socks large enough to go over the doll's shoes. Thus, it was possible for the child to put the shoes on first, and then the socks over the shoes.

Since the child might perceive (rightfully!) some of the tasks as silly and feel inhibited in acting them out, special instructions were given for this act-out task. The instructions were given to the child through a puppet. "Listen carefully to my puppet friend and do just what he says. Sometimes he says things right and sometimes he says them mixed up. So listen carefully and do just what he says. If you want to, you can tell me when he's mixed up, but try to do what he says anyway..." The puppet then spoke sentences of the type, "Put on the doll's socks and then put on her shoes."

Results. Not surprisingly, the data demonstrated that children will ignore the temporal connective and the order in which a sentence is spoken, if the relations between the two clauses have an inherent logical order (see Table 15). They attend only to the relations between the clauses and act them out. At the first assessment, of the 105 sentences spoken in an illogical order, children acted-out 79 of these clauses in the logical order, and only acted-out 12 sentences illogically. In 14 of the sentences one of the actions was omitted. Ten of the 12 sentences acted-out illogically were done by the older children, indicating they were either understanding the game better than the younger children or perhaps were beginning to develop a metalinguistic awareness -- an ability to play with the meaning of the sentences. Five of the arbitrary responses were to sentences with and then, a temporal connective well-mastered even by the first assessment.

By the fourth assessment, 29 illogical sentences were acted-out illogically and there were no omissions. About 50% of these were acted-out by the 10 youngest children (Groups A and B) and 50% by the oldest children (Group C).

Given a logical sentence, the children overwhelmingly acted-out the sentences in the logical manner, regardless of temporal connective.

The point of this little study was to demonstrate that a child's first strategy when acting-out a complex sentence is to search for a meaningful relation within the sentence, or to find some appropriate contextual cues, and act upon that relation. It is only in the case when the relations between clauses in a sentence are illogical that children may resort to other strategies.

2.5.2 Imitation: Sentence Repetition

Purpose. Because of the number of clause omissions in the declarative sentences, we decided that we needed an independent measure of the child's ability to recall complex sentences. We first attempted this task in a classroom because we found that young children were hesitant to repeat sentences in the laboratory situation. However, results from the naturalistic setting were ambiguous. Keith Stenning,[9] a colleague at the Rockefeller University, suggested the use of earphones, which proved to be a successful laboratory situation.

Description. The imitation study had 2 parts: (1) familiarization period, in which children adjusted to the idea of headphones and that they had to repeat (not act-out) what they heard through the headphones; and (2) the actual study.

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[9] Dr. Keith Stenning, now at the University of Liverpool, was a collaborator on all studies dealing with imitation.

Table 15

Children's Responses to Logical and Illogical Sentences by Assessment Period
(N=15)

Given a Logical Sentence	Response Acted-Out Logically			Response Acted-Out Illogically			Response Acted-Out With One Clause Only		
	Ass I	Ass III	Ass IV	Ass I	Ass III	Ass IV	Ass I	Ass III	Ass IV
A before B	14	12	15	0	3	0	1	0	0
After A, B	15	14	14	0	1	1	0	0	0
Before B, A	10	13	15	1	2	0	4	0	0
B after A	14	13	14	1	2	1	0	0	0
A and then B	12	15	15	0	0	0	3	0	0
B but first A	15	15	15	0	0	0	0	0	0
B next B	13	14	15	1	1	0	1	0	0
Total/105	93	96	103	3	9	2	9	0	0
Given an Illogical Sentence									
A before B	9	11	11	2	4	4	4	0	0
After A, B	15	8	12	0	7	3	0	0	0
Before B, A	8	13	11	3	2	4	4	0	0
B after A	12	13	10	1	2	5	2	0	0
A and then B	7	8	12	5	5	3	3	2	0
B but first A	15	10	9	0	5	6	0	0	0
A next B	13	12	11	1	3	4	1	0	0
A and B									
Total/105	79	75	76	12	28	29	14	2	0

For the familiarization phase we devised a topic with 4 separate sections. First, there was a section with music. This part was used to help the child adjust to the earphones and demonstrate to the child that only the person with earphones could hear what was "inside." This was an important phase since it gave the child later a purpose for repeating the stories as accurately as possible.

After the child was thoroughly familiar with the earphones he heard a sentence and had to act-out what he heard. In the third phase, he heard a series of instructions which he was supposed to repeat to the experimenter. The fourth phase was a sentence repetition task. The child was given a picture book and through the earphones, he heard a story which he then repeated to his friend, a large stuffed bear.

For the actual study, the children heard a series of 14 sentences, seven sentences which were similar to the imperative act-out sentences and seven sentences which were similar to the declarative sentences. In addition, a tape based on the logical-illogical act-out sentences was also devised.

Results. The sentences repetition task verified the results from our comprehension task. Twice as many clauses were deleted from the declarative sentences as opposed to the imperative sentences (see Table 16). Furthermore, 75% of the omissions in the sentences occurred on the first clause spoken. We wondered if we analyzed the omissions on the comprehension task by order of clauses spoken we could get the same result. Preliminary analyses indicated that the number of clause deletions were split between the first clause and the second clause in the act-out tasks. At this point we stopped the analysis of the longitudinal data and realized that these preliminary findings were sufficiently ingriguing to merit our repeating the study with a larger sample and with better controls. (Appendix E described this study and its results.)

Although we did not continue the clause deletion analysis, we did examine the imitation data to see whether the children made any errors of substitutions or paraphrasing which might give us some clues to how the children interpret these connectives. The matrix on the following page (Table 17) presents the results of these analyses. The connectives listed in the top column are the ones the child heard, the connectives listed in the rows are the connectives the children spoke. Not surprisingly, omitting the connectives in the sentence was the most common error in the sentence repetition task. This error occurred with all the connectives although it was not frequent with A while B. A before B and and were the two connectives most frequently used by the children. If we just examine the number of times one connective was substituted for another, and was the most frequent substitution made. However the role of and in a sentence is merely to conjoin two events and does not mark temporal order. The most frequent temporal connectives used were then (and then), first (and first), and A before B.

A before B and and were used most frequently to substitute for the connective until. Such a substitution might indicate that children have already acquired the idea that part of the

Table 16

Percent Omissions By Clause and Sentence Type

Clause Omissions	Sentence Type	
	Imperative	Declarative
First-Clause-Spoken	22	53
Second-Clause-Spoken	12	22

TABLE 17

Sentence Repetition Task: Frequency of Connectives Spoken as a Function of Connectives Heard
Imperative and Declarative Sentences Combined
N = 14

Connectives Spoken		Connectives Heard								
Code #		(1)	(2)	(3)	(4)	(5)	(6)	(7)	TOTAL	TOTAL SUBS.
(1)	B after A	24	1	5	3	1	1	1	37	13
(2)	A before B	4	24	6	9	2	1	5	51	27
(3)	B but first A	2		9	1	1	7		20	11
(4)	A until B		1		16				17	1
(5)	After A, B	3				34	1	1	39	5
(6)	Before B, A	1	3	2	1	1	22		30	8
(7)	A while B	4	3		1	1	2	23	34	11
	Omission	7	7	6	4	8	10	13	55	55
	and	5	6	7	10	5	2	7	42	42
	A (and) then B	3	3	6	4	2	3	4	25	25
	first, and first	1	4	11	2		3		21	21
	when						1		1	1
	until when		1						1	1
	A but before B			1					1	1
	No Response[1]	1	1		1	1	1		5	-
	TAPE MISSING	1	1	3	4		2	2	13	-
	TOTAL	56	56	56	56	56	56	56	392	

meaning of until is that one event precedes another. However, they still have not acquired the idea that until also implies that the first event must at least continue up to the time of the second event. Before does not by itself imply the duration of the first event. Children's use of before, a substitute for until, verified some of the difficulties we had in scoring sentences with until in our act-out tasks. (See footnote 7.)

Another interesting finding is the substitutions made for the connective but first. In our act-out sentences, children acquired the meaning of but first very early. In fact, their performance with but first was better than with some order-of-mention connectives and better than all the sentences which required the children to act-out events in the reverse order in which they were mentioned. One reason may be the way the children recoded the sentence. The matrix indicates that first was used most frequently as a substitute for but first. The children reorganized the sentences of the form B but first A, to "First A, (and) B."

A until B was used least often as a substitute, as were Before B, A and After A, B. The latter two sentences were both ones in which the connective appears in the initial position. Since the connective B after A is the one least well-understood according to the comprehension data, we expected it to have been the one used least. The data from the imitation data seems to indicate that not only does the complexity of the meaning of the connective play an important role in the child's early imitation, but also its syntactic role. There were five sentences in which the connective was placed in the middle position of the sentence. Of these five connectives, four were used more frequently as substitutes than either of the two connectives which were used in the initial position of the sentence. These substitutions were independent of the difficulty that children had with these connectives in the comprehension task.

Thus, the data from the imitation study indicate: (1) that children most frequently omit the temporal connective; (2) when they do begin to use a connective, they use and which is not a temporally marked connective; (3) of the temporal connectives, they substitute then, first and before (in the middle position of a sentence) most frequently; (4) children substitute connectives located in the initial position of a sentence least often.

3. Results

The second purpose of the proposed research was to conduct studies on the cognitive basis of temporal lexical development. The most detailed theoretical explanation of children's acquisition of temporal connectives has been proposed by Eve Clark (1971; 1973). She delineates four stages in a child's acquisition of before and after. According to Clark, in the first stage children do not understand either word; they use an order-of-mention strategy in acting-out all complex temporal sentences. In the second stage, children demonstrate an understanding of before, but not after; in the third, children interpret after as though it means before; in the final stage they understand both connectives. She interprets this ordering as support for the notion that children acquire separate meaning components (or "semantic markers") of before and after hierarchically, from the superordinate component on down. The superordinate component is TIME, which is hierarchically differentiated into notions of SIMULTANEITY and SUCCESSIVENESS. SUCCESSIVENESS, in turn, is subdivided into a notion of PRIORITY: +PRIOR (the notion of "before now") precedes -PRIOR (the notion of "after now").

Four experiments (one longitudinal and three cross-sectional) were conducted to test some of the implications of Clark's semantic markedness hypothesis. The following section summarizes briefly the results from these studies.

3.1 Cross-Sectional Study I

In our first study we wanted to get a sense of how difficult the various temporal terms (before, after, but first, next, then,

when) were in relation to each other. As mentioned previously, before and after were only two connectives that children had to master. We conducted a cross-sectional with 90 children between the ages of three and five-and-a-half.[10] The test materials were identical to the act-out imperative and declarative sentences developed for the longitudinal study (see 2.5.1).

Results. The children's responses were scored as in the previous studies -- first-clause-first; second-clause-first; omissions; simultaneous; other. Table 18 indicates the percent correct for each connective as a function of age. A reasonably orderly development of the connectives emerges. Previous research (Clark (1971) for example) had led us to expect that those connectives that fit an order-of-mention strategy would develop first, and that those connectives whose order-of-mention does not correspond to the order in which the events occur would develop more slowly. Children as young as three performed at ceiling level for three of the forward sentences, A and then B, A next B, and A before B. The three backward sentences, B but first A, B before A, and B after A are the most difficult for the youngest children. However, on two forward connectives the children did not perform as expected. When A, B and after A, B, both forward sentences, were significantly more difficult than the other three forward sentences. Curiously, by age 3½ children's performance on B but first A showed a distinct developmental gain; their performance increases from 63% to 95% correct. Performance on when A, B also demonstrated a clear gain during that age period, whereas after A, B showed a much smaller increase. By age four, the children seemed to have

[10] We are indebted to Phyllis Goldstein and Alina Shumsky for data collection and analysis.

TABLE 18
Percent of Correct Response by Age,
Sentence Type and Connective

Connective	Age Group and Sentence Type[a]									
	I		II		III		IV		V	
	I	D	I	D	I	D	I	D	I	D
A and then B	94	86	97	94	97	97	100	97	97	97
A next B	92	92	97	94	94	97	94	100	100	100
A before B	100	86	97	94	94	97	94	100	100	97
After A, B	58	86	81	83	89	94	89	86	100	92
When A, B	75	69	97	83	92	92	100	100	100	100
B but first A	67	61	94	97	94	89	97	94	100	97
Before B, A	61	31	72	61	69	75	89	78	89	92
B after A	36	28	53	50	53	69	67	59	89	83

[a]I = Imperative sentences; D = Declarative sentences

mastered all the connectives except before B, A and B after A. It isn't until age 5 that there are no significant differences among the connectives.

Thus, one trend that emerges is that around age 3, A and then B, A next B, and A before B are the easiest sentences. When A, B and After A, B are somewhere in the middle, and the three backward sentences are the most difficult. However, by age 3½, children's performance on a coordinating conjunction such as B but first A is equal to that of A next B, A and then B, and A before B, and is significantly better than After A, B. Comparison of the children's performance on B but first A and After A, B indicates that how children respond to these sentences cannot be attributed entirely to a first-clause-first strategy or to an inability to reverse the order in which events are mentioned.

Table 19 presents an analysis of the response patterns by connectives for the youngest three age groups. Reversals accounted for most of the errors with After A, B and When A, B. Again, the fact that the children used a second-clause-first strategy when an order-of-mention response would have been appropriate gave us additional support for rejecting an order-of-mention response as the primary temporal strategy for very young children.

The data on omissions replicate the findings from the declarative sentences in the longitudinal sample. In fact, the number of clause deletions in the declarative sentences surprised us. For about 10% of the responses one of the actions was not performed. Clark, in her study, reported no clause deletions, yet our declarative sentences were almost identical to hers; age and social class were similar. We cannot explain the lack of

TABLE 19

Response Patterns by Sentence Type,

Connective and Age Group

(in percents)

Connective	Response Patterns																							
	First Clause First						Second Clause First						Simultaneous						Omission					
	I[a]		II		III		I		II		III		I		II		III		I		II		III	
	b I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D	I	D
A before B	100	86	97	94	94	97	0	11	0	0	6	0	0	0	3	0	0	0	0	3	0	6	0	3
After A, B	58	86	81	83	89	94	28	6	17	8	11	6	3	0	3	0	0	0	11	8	0	8	0	0
Before B, A	33	53	28	17	28	19	61	31	72	61	69	75	6	0	0	3	3	0	0	17	0	19	0	6
B after A	64	58	47	44	39	22	36	28	53	50	53	69	0	0	0	0	8	0	0	14	0	6	0	8
Mean	64	71	63	60	63	58	31	19	36	30	35	38	2	0	1	1	3	0	3	11	0	10	0	4

[a] N=18 per group Age Group I=3;0-3;6 Age Group II=3;6-4;0 Age Group III=4;0-4;6

[b] I=Imperative sentences D=Declarative sentences

clause deletions in the Clark study, but we do feel that the number of clause deletions in our study was due to the young child's inability to remember both clauses. This finding led us to study how well children can remember two clause sentences. We wanted to find an independent measure of the child's ability to recall complex sentences.

3.2. Children's Memory and Comprehension for Temporal Connectives

In the next study, which was conducted in collaboration with Dr. Keith Stenning (See Appendix E), we asked the following question: To what extent does a child's recall of a complex sentence determine his comprehension performance?

We tested 72 children, 36 lower socio-economic black children and 36 middle-class white children whose ages ranged from 3 to 6 years. Each child was asked to repeat temporal statements of the type A before B, as well as act them out. We tested the children with sentences of the form A before B, After A, B, Before B, A, B after A, A and then B, and B but first A. The most interesting results occur with the four before/after constructions. The comprehension data did not reveal any developmental trends. The oldest children were making as many errors as the youngest children. However, clause deletions (omissions) did show a developmental trend. Since these deletions showed the only clear developmental trend, we analyzed them more carefully. The imitation (sentence repetition) data showed more omissions of the first clause, whereas the comprehension data showed more omissions of acting-out the second clause. From this data we derived an estimate of what fraction of the time the child deletes a clause

because of a failure of immediate memory or because he is focusing on the information contained in the main clause. Our p values (the probability of deleting the first clause) due to failure of immediate memory led us to the following conclusions: (1) an ordering of the difficulty of the connectives was derived and this order was similar to that found in other studies; (2) our estimate for p revealed black/white differences. We found that the black children made 56 deletions in imitation and only 28 deletions in comprehension whereas the white children made an equal number of deletions in imitation and comprehension, 43. The estimated value of p obtained for the black children is 0, so, under our assumptions, no errors in their comprehension data were attributable to failure of immediate memory. On the other hand, the estimated value of p for the white children was .68, twice as many of their errors were due to failure of immediate memory as were due to acting-out the main clause only. We have speculated that the white children may have placed more reliance on repeating the sentence to themselves as a guide to acting it out, and since sentence repetition leads to a memory effect, this is the effect that dominates in their comprehension data. (This experiment has been repeated with controls for experimenter effects and voice on tape -- black voice vs. white voice, but data from this study have not yet been analyzed.)

3.3 Unfamiliar Temporal Connectives: A Test of the First-Clause-First Hypothesis.

In order to test Clark's hypothesis that children adopt a first-clause-first strategy when they do not know the meaning of

connectives we tested sixteen children, 8 whose mean age was 3;0 and 8 whose mean age was 4;6 with a set of 20 act-out sentences. Sixteen were meaningful temporal sentences conjoined by before and after and four were nonsense sentences conjoined by two nonsense words, lerbit and tomal. We found that the older group gave an order-of-mention response significantly more often than the younger children and gave reveral responses significantly less often. Thus, we decided to examine the contribution of the sentential position (medial or initial) to the children's response patterns. The various response patterns for the older children gave a clear ordering of response strategies as a function of sentential position of the connective. The children's response strategies to the nonsense connectives were very similar to their responses to before and after. The remarkable aspect about this ordering was that it was derived entirely from nonsense words positioned syntactically as though they were meaningful temporal connectives.

The above three studies confirmed our suspicion that children's superior performance on sentences with before may very well be an artifact of the laboratory situation.

3.4 Lexical Development: A Mini-longitudinal Approach

In the fourth study we reexamined our longitudinal data in order to answer the question whether individual children do in fact progress through hierarchical stages as outlines by Clark. (See Appendix F for a detailed description of this study.)

We took the data from the act-out imperative sentences for the ten youngest children in our longitudinal sample. When the data were analyzed as if they were four separate cross-sectional studies of children differing in age by seven weeks, the general trend from the data confirmed Clark's theory. However, when each child's data was analyzed longitudinally there was much heterogeneity in the children's responses; only 2 of 10 children showed any semi-stage progression as predicted by existing theories. In fact, none of the children followed similar paths in achieving mastery of these time wrods.

4. Conclusion

The core of the time concept is relatively simple, growing out of the child's experience of successive moments. It is evident from studies describing the child's early perceptual development that he has an "idea" about the present moment -- of now, of the notion of earlier than now and later than now, and he has also appreciated the idea that two events can occur at the same time. Thus, the experimental data on children's acquisition of time language -- which stresses a relatively late development -- suggests that the complexity of the time concept lies in its linguistic expression, rather than its conceptual core.

We believe that there are two important stages in the child's linguistic acquisition of temporal conjunctions. In the first stage, which happens early in the child's linguistic development, he acquires the idea that there is a certain class of words that belong to a semantic domain called time. Thus,

during this stage, which occurs rather quickly, the child learns that words such as before, after, first, last, when, while, earlier, later, etc. have something to do with time -- perhaps even with some notion of sequence.

During the second stage, which may last a very long time, perhaps five years or more, the child must learn to map these words in his temporal lexicon onto both his conceptual understanding and his growing syntactic competence. I do not want to go into detail about the kinds of linguistic distinctions that an adult speaker might need to make in order to use temporal conjunctions, I just want to emphasize the point that there are no psychological grounds for assuming that a child's knowledge of temporal relations is hierarchically structured.

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APPENDIX A

NIE Proposal

Contextual Variation in Linguistic Performance

Available at NIE

APPENDIX B

Spontaneous Usages of Searched Temporal Terms

Group B

Spontaneous Usages of Searched Temporal Terms

Term	Subject I.D. Number	Utterance
Before	12M	Let's get them on the bench and put them down, before they break.
	11F	...We did all those questions before.
After	13M	After cereal. (answering a "when" question)
Next	11F	I'm next to you, Joey.
	12M	She's five and six. She had her next birthday.
	12M	Next Saturday. (answering "when?")
First (then)	9M	And the first thing you do is put your jammies on.
	12M	Eat! But first bite. And then you eat and then go, I go to bed.
	12M	First in the coffee pot.
	12M	We have to get those clothes off first.
	8F	No, we're going to the Naash station first, and then, we're going to the zoo. And then we go home.
	8F	Wait, where, um, I got here first.
Then	9M	Then you put jelly on it.
	9M	Then Joey (does/comes)?
	9M	And then go to bed and then clean your teeth.
	9M	And then go back home to, and have, um, games.
	9M	O.K. Now you're at the (inaud) then you go to bed, um, then you go to bed.
	10F	First you climb up in the bathtub, then you wash yourself, then you, then, get out of the bathtub. Then you get dressed.

Group B
Then cont.

	11F	Then we put butter on it.
	11F	Then, then you eat it.
	12M	My daddy just tells me my mummy has to get up, and then he wakes my mother up.
	12M	And then wake up and have cereal.
	12M	Give me my cup, then we're gonna, full them up.
	8F	And then brush your hair.
	8F	And then your clothes. .
	10F	Then walk to school
When	9M	When we, we get, we go the nother school.
	9M	When I had a birthday?
	12M	When?
	13M	When he gets, I mean, uh, we get vitamins.
	12M	It's gonna blow our coats away, when it's not zippers up.
	10F	Me too. When I move to Nashville.
	8F	And when do you get up
	12M	But when is the tape recorder gonna go?
	12M	When we go to bed, we have it.
	8F	This looks like water when you pour it, right? and now it looks like orange juice.
	12M	MMM and when we go to sleep.
	11F	When we wake up.
	9M	Cause he just knows when I go to bed.
	12M	When I was a baby, I used to be three.
	12M	When could we have our cookies?

Group B
When cont.

12M	When are you gonna eat dinner? When you gonna eat?
11F	When Joey didn't have one.
13M	When?
12M	Well, we're filling it up and when we', when I'm done with mine, you could have it.

Group C

Spontaneous Usages of Searched Temporal Terms

Term	Subject I.D. Number	Utterance
Before	17F	I want to wash this off before, I can stick some more things on.
	17F	Before I paint?
After	15F	After I finished, I could paint ...
	18M	After 10 o'clock.
	19M	When, after you look.
	16F	That's gonna happen after when I'm 6.
Next	16F	The one next to me?
	17F	My mom's gonna bring me next time.
	16F	Could I show you 'em. Next time.
	16F	Next Sunday. (answ. "when" ?)
	15F	Next Sunday. (answ. "when" ?)
	16F	I do next time
	19M	Run around the potato next.
	19M	I'm next. (3 times)
	16F	Nellie, you're next.
	16F	Yeah, you're next.
	16F	O.K. Alvin, you're next.
	16F	OK., then you're next.
	19M	The next day
	16F	Next time
	16F	Next time?
	19M	Next week.
First	16F	First... I'm going to call my aunt.
	18M	That's not the first.
	18M	Um, the first Friday.

Group C
First cont.

	19M	You go on the box first.
	16F	Wanna play Caps for Sale? I'll be first.
	16F	I got eat my soup first.
	19M	First (beginning action)
Then	16F	Let's see who riding in the car and then get one of the dollies.
	17F	How do you pin it on my shirt then?
	17F	Mommy puts it in there too, and then she puts it on a stove.
	18M	Once I didn't have it (like it) and then I tasted it and I loved it.
	16F	And then kiss the bear.
	16F	You kiss a bear and you can sit on a chair and then you go back in your seat.
	16F	It goes tick-tock, tick-tock, and then you see it ring.
	16F	And then comes midnight, then see twelve o'clock comes, then one.
	16F	Then I'll do it.
	19M	And I'll say, TS, TS, and then, take the hats off your head.
	16F	Then he's gonna be five?
	19M	And then you just walk around the room, and then, and then, when you meet this, sit and rest.
	19M	Then my family doesn't wake up.
When	18M	But when you talk to them they don't talk back.
	19M	When will it stick?
	18M	When are you going to cut this?
	18M	But I have two numbers when I go to sleep. Sometimes I go to sleep at 8, ... sometimes 5.

Group C
When cont.

18M	Guess when I was there two days?
15F	I mean when we eat.
15F	When we have snack, Mommy will come?
19M	I get up when it's time to go to school.
18M	When we're coming back from school.
16F	When, now?
17F	When I went to Grandma's house. . .
18M	Only when you're babies.
15F	When my Daddy, Daddy had August.
15F	When she was a baby.
16F	When my birthday was
17F	When all my cousins came
17F	When I'm all finished, you can have another one.
19M	When it was Easter at my house, when already didn't pass.
18M	You know when I went to sleep (2 times)
18M	When my poppa goes to sleep.
18M	I go to sleep when my papa goes to sleep.
15F	Ah, when I'm gonna to say it's Rebecca's turn?
15F	And when I'm gonna be the leader?
15F	When it's going to be my turn?
16F	When it comes, when it comes twelve o'clock at night.
16F	When they put the 2 handles on the numbers.
16F	When Easter comes!
16F	When I'm gonna be seven I'm going to first grade.

Group C
When cont.

	19M	When they throw them to bring the hats down.
	19M	When you stop walking.
	19M	When we're finished with the story.
	19M	When it's the last day of school.
	18M	When the school is over.
While	17F	Can we, can we put the shells in while you, while you finish?
	16F	He hasn't played for a while.
Until	19M	Until you get to the tree and rest, OK? (2 times)
	19M	Don't wake up, until I take these off.
	18M	You know what? It was snowing in the morning until night.

APPENDIX C

Copies of Test Forms as Administered

ACT-OUT SENTENCES I
IMPERATIVE FORM; SAME VERB

Name _____ Age: yrs___mo___ wk____

Date _____ Session # _____ Adm. #_____

Tr.	Situtation L	Situtation R	Sentence	Child's Actions 1st	Child's Actions 2nd	Child's Actions Simul.	Sc.
1)	cray	cup	PICK UP THE CUP BEFORE YOU PICK THE CRAYON.				
2)	bttl	carr	PICK UP THE CARROT, NEXT PICK UP THE BOTTLE.				
3)	iron	chair	WHEN YOU PICK UP THE IRONPICK UP THE CHAIR.				
4)	truk	watch	BEFORE YOU PICK UP THE TRUCK, PICK UP THE WATCH.				
5)	brsh	screw drvr	PICK UP THE SCREWDRIVER AFTER YOU PICK UP THE BRUSH.				
6)	sci- ssor	miror	PICK UP THE MIRROR BUT FIRST PICK UP THE SCISSORS.				
7)	shoe	whstl	PICK UP THE WHISTLE AND THEN PICK UP THE SHOE.				
8)	glas- ses	plate	PICK UP THE GLASSES BEFORE YOU PICK UP THE PLATE.				
9)	comb	ruler	PICK UP THE COMB WHILE YOU PICK UP THE RULER.				
10)	hammer	car	AFTER YOU PICK UP THE HAMMER, PICK UP THE CAR.				
11)	book	purse	TOUCH THE PURSE UNTIL YOU PICK UP THE BOOK.				
12)	ball	block	PICK UP THE BALL AND PICK UP THE BLOCK.				
13)	bttle	brush	TOUCH THE BRUSH AND PICK UP THE BOTTLE.				

ACT-OUT SENTENCES I

IMPERATIVE FORM; SAME VERB

Name _____ Age: yrs. ___ mo. ___ wk. ___

Date _____ Session # ___ Adm. # _____

Situation L	Situation R	Sentence	Child's Actions 1st	Child's Actions 2nd	Child's Actions Simul.	Sc.
lamp	hanger	TOUCH THE HANGER AND PICK UP THE LAMP.	____	____	____	___
key	comb	PICK UP THE COMB WHILE YOU PICK UP THE KEY.	____	____	____	___
table	block	TOUCH THE TABLE UNTIL YOU PICK UP THE BLOCK.	____	____	____	___
umbrel-la	peg	AFTER YOU PICK UP THE PEG PICK UP THE UMBRELLA.	____	____	____	___
penny	glasses	PICK UP THE PENNY AND THEN PICK UP THE GLASSES.	____	____	____	___
purse	chair	BEFORE YOU PICK UP THE CHAIR PICK UP THE PURSE.	____	____	____	___
spoon	telephone	PICK UP THE SPOON BUT FIRST PICK UP THE TELEPHONE.	____	____	____	___
chair	peg	PICK UP THE CHAIR, NEXT PICK UP THE PEG.	____	____	____	___
key	block	WHEN YOU PICK UP THE BLOCK, PICK UP THE KEY.	____	____	____	___
hanger	telephone	PICK UP THE HANGER BEFORE YOU PICK UP THE TELEPHONE.	____	____	____	___
umbrel-la	lamp	PICK UP THE UMBRELLA AFTER YOU PICK UP THE LAMP.	____	____	____	___
table	comb	PICK UP THE COMB AND PICK UP THE TABLE.	____	____	____	___

ACT-OUT SENTENCES II
IMPERATIVE FORM; SAME VERB

Name: _____ AGE: Yrs. ____ Mos. ____ Wks. ____

Date: _____ Session # _____ Adm. # _____

Tr.	Situation L	Situation R	Sentence	Child's Actions 1st	2nd	Simul.	Sc.
1)	tele-phone	cup	PICK UP THE CUP BEFORE YOU PICK UP THE TELEPHONE.	___	___	_____	_____
2)	brush	rattle	PICK UP THE RATTLE, NEXT PICK UP THE BRUSH.	___	___	_____	_____
3)	iron	guitar	WHEN YOU PICK UP THE IRON PICK UP THE GUITAR.	___	___	_____	_____
4)	duck	watch	BEFORE YOU PICK UP THE DUCK PICK UP THE WATCH.	___	___	_____	_____
5)	truck	screw-driver	PICK UP THE SCREWDRIVER AFTER YOU PICK UP THE TRUCK.	___	___	_____	_____
6)	knife	frog	PICK UP THE FROG BUT FIRST PICK UP THE KNIFE.	___	___	_____	_____
7)	scis-sor	mirror	PICK UP THE MIRROR AND THEN PICK UP THE SCISSOR.	___	___	_____	_____
8)	boat	plate	PICK UP THE BOAT BEFORE YOU PICK UP THE PLATE.	___	___	_____	_____
9)	swan	ruler	PICK UP THE SWAN WHILE YOU PICK UP THE RULER.	___	___	_____	_____
10)	ball	block	AFTER YOU PICK UP THE BALL PICK UP THE BLOCK.	___	___	_____	_____
11)	hammer	car	TOUCH THE CAR UNTIL YOU PICK UP THE HAMMER.	___	___	_____	_____
12)	shoe	whistle	PICK UP THE SHOE AND PICK UP THE WHISTLE.	___	___	_____	_____
13)	fish	bracelet	TOUCH THE BRACELET AND PICK UP THE FISH.	___	___	_____	_____

ACT-OUT SENTENCES II

IMPERATIVE FORM; SAME VERB

Name: _____ Age: Yrs. ____ Mos. ____ Wks. _____

Date: _____ Session # _____ Adm. # _____

Situation L	Situation R	Sentence	Child's Actions 1st	Child's Actions 2nd	Child's Actions Simul.	Sc.
Tooth-brush	Horse	TOUCH THE HORSE AND PICK UP THE TOOTHBRUSH.	___	___	___	___
Ele-phant	Spoon	PICK UP THE SPOON WHILE YOU PICK UP THE ELEPHANT.	___	___	___	___
Fish	Pipe	TOUCH THE FISH UNTIL YOU PICK UP THE PIPE.	___	___	___	___
Motor-cycle	Knife	AFTER YOU PICK UP THE KNIFE PICK UP THE MOTORCYCLE.	___	___	___	___
Chair	Camel	PICK UP THE CHAIR AND THEN PICK UP THE CAMEL.	___	___	___	___
Screw	Pig	BEFORE YOU PICK UP THE PIG PICK UP THE SCREW.	___	___	___	___
Kanga-roo	Sink	PICK UP THE KANGAROO BUT FIRST PICK UP THE SINK.	___	___	___	___
Hippo-potamus	Hair Brush	PICK UP THE HIPPOPOTAMUS, NEXT PICK UP THE HAIR BRUSH.	___	___	___	___
Paper Clip	Bear	WHEN YOU PICK UP THE BEAR PICK UP THE PAPER CLIP.	___	___	___	___
Sink	Boot	PICK UP THE SINK BEFORE YOU PICK UP THE BOOT.	___	___	___	___
Tooth-brush	Camel	PICK UP THE TOOTHBRUSH AFTER YOU PICK UP THE CAMEL.	___	___	___	___
Hippo-potamus	Pipe	PICK UP THE PIPE AND PICK UP THE HIPPOPOTAMUS.	___	___	___	___

ACT-OUT SENTENCES III
IMPERATIVE FORM; SAME VERB

Name: _____ Age: yrs. _____ mos. _____ wks. _____

Date: _____ Session # _____ Adm. # _____

Tr. Situation L	R	Sentence	Child's Actions 1st	2nd	Simul.	Sc.
flower	lipstick	BEFORE YOU SMELL THE FLOWER, SMELL THE LIPSTICK.				
cup	pencil	PICK UP THE CUP WHILE YOU PICK UP THE PENCIL.				
glove	plate	TOUCH THE PLATE UNTIL YOU THROW THE GLOVE.				
ele-phant	horse	WALK THE HORSE BUT FIRST WALK THE ELEPHANT.				
chair	doll	PAT THE CHAIR AND HIT THE DOLL.				
mommy	baby	KISS THE MOMMY BEFORE YOU KISS THE BABY.				
pen	spoon	DROP THE SPOON AFTER YOU DROP THE PEN.				
truck	car	WHEN YOU ROLL THE TRUCK, ROLL THE CAR.				
apple	carrot	AFTER YOU EAT THE APPLE, EAT THE CARROT.				
ribbon	flag	WAVE THE FLAG AND WAVE THE RIBBON.				

ACT-OUT SENTENCES III
IMPERATIVE FORM; SAME VERB

Name: _____ Age: yrs. ____ mos. ____ wks.

Date: _____ Session # _____ Adm. # _____

Tr. Situation L R	Sentence	Child's Actions 1st	2nd	Simul.	Sc.
girl puppet	KISS THE PUPPET BEFORE YOU KISS THE GIRL.				
screw ball	WHEN YOU ROLL THE BALL ROLL THE SCREW.				
gun book	PAT THE GUN AND HIT THE BOOK.				
leaves chalk	BEFORE YOU SMELL THE LEAVES SMELL THE CHALK.				
pliers block	DROP THE BLOCK AFTER YOU DROP THE PLIERS.				
pig giraffe	WALK THE PIG BUT FIRST WALK THE GIRAFFE.				
ruler crayon	PICK UP THE RULER WHILE YOU PICK UP THE CRAYON.				
fork doll	AFTER YOU HIT THE DOLL HIT THE FORK .				
yo-yo key	TOUCH THE YO-YO UNTIL YOU THROW THE KEY.				
spoon paper	WAVE THE SPOON AND WAVE THE PAPER.				

MASTER LIST OF IMPERATIVE SENTENCES FOR TIME IV

L = object on the left.

R = object on the right.

Before you pick up the R pick up the L

Before you roll the L roll the R.

After you eat the R eat the L.

After you throw the L, throw the R.

Pat the R before you pat the L.

Drop the L before you drop the R.

Pick up the R after you pick up the L.

Pat the L after you pat the R.

Pat the R and throw the L.

Eat the L and drop the R.

Pick up the R and then pick up the L.

Drop the L and then drop the R.

Roll the R next roll the L.

Throw the L next throw the R.

Eat the R but first eat the L.

Pat the L but first pat the R.

Pick up the R while you pick up the L.

Roll the L while you roll the R.

When you pat the R pat the L.

When you drop the L drop the R.

Don't eat the R until you eat the L.

Don't throw the L until you throw the R.

While you pat the R pick up the L.

While you eat the L drop the R.

Pick up the R but before you do that pick up the L.

Throw the L but before you do that throw the R.

Pick up the R but pick up the L first.

Throw the L but throw the R first.

Don't roll the R before you roll the L.

Don't drop the L before you drop the R.

Roll the R while you pick up hte L.

Pat the L while you pick up the R.

Pat the R as long as you pat the L.

Rub the L as long as you rub the R.

Pick up the R when you pick up the L.

Drop the L when you drop the R.

Throw the R at the same time as you throw the L.

Drop the L at the same time as you dorp the R.

ACT-OUT SENTENCES III
NONSENSE SYLLABLES USED AS CONNECTIVES

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date: _____ Session # _____ Adm. # _____

Situation L	Situation R	Sentence	Child's Actions 1st	Child's Actions 2nd	Child's Actions Simul.	Sc.
pine-apple	envelope	BITTLER YOU PICK UP THE PINEAPPLE, YOU PICK UP THE ENVELOPE.	_____	_____	_____	_____
kangaroo	car	PUSH THE CAR ALSHEM YOU PICK UP THE KANGAROO.	_____	_____	_____	_____
glue	string	PICK UP THE STRING, BITTLER YOU PICK UP THE GLUE.	_____	_____	_____	_____
peach	truck	ALSHEM YOU PICK UP THE PEACH, PUSH THE TRUCK.	_____	_____	_____	_____

ACT-OUT SENTENCES III
NONSENSE SYLLABLES USED AS CONNECTIVES

(2)

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date: _____ Session # _____ Adm. #_____

Situation L	Situation R	Sentence	Child's Actions 1st	2nd	Simul.	Sc.
frog	guitar	ALSHEM YOU PICK UP THE GUITAR, PUSH THE FROG.	_____	_____	_____	_____
ruler	comb	PICK UP THE RULER BITTLER YOU PICK UP THE COMB.	_____	_____	_____	_____
fish	boat	PUSH THE BOAT ALSHEM YOU PICK UP THE FISH.	_____	_____	_____	_____
purse	block	BITTLER YOU PICK UP THE BLOCK, PICK UP THE PURSE.	_____	_____	_____	_____

ACT-OUT SENTENCES I

LOGICAL/ILLOGICAL SENTENCES DECLARATIVE FORM; DIFFERENT VERB

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date Run: _____ Session # _____ Adm. # _____

INSTRUCTIONS: In this game we're going to do a lot of things for the doll. I brought along a very silly friend of mine to tell you what to do. Some of the things she tells you to do are just fine--but other things are so very silly! Even though they are silly I want you to do them anyway--exactly the way she tells you to. You'll have to listen carefully each time and if you want to, you can tell me which ones are o.k. and which ones are silly before you do them. (Note: Can elaborate on instructions if child needs more).

Sentence	CHILD'S RESPONSE: First Action	Second Action	Other/ Comments
1. Give the doll a bath before you dry her.			
2. Put on the doll's blouse, next put on her undershirt.			
3. When you pour the water in the cup, give the doll a drink.			
4. Before you put on the doll's blouse, put on her undershirt.			
5. Give the doll a bath after you dry her.			
6. Give the doll a drink, but first pour the water in the cup.			
7. Give the doll a bath and then dry her.			
8. After you give the doll a drink, pour the water in the cup.			
9. Put on the doll's blouse and put on her undershirt.			

ACT-OUT SENTENCES I

LOGICAL/ILLOGICAL SENTENCES DECLARATIVE; DIFFERENT VERB

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date Run: _____ Session # _____ Adm. # _____

INSTRUCTIONS: In this game we're going to do a lot of things for the doll. I brought along a very silly friend of mine to tell you what to do. Some of the things she tells you to do are just fine--but other things are so very silly! Even though they are silly I want you to do them anyway--exactly the way she tells you to. You'll have to listen carefully each time and if you want to, you can tell me which ones are o.k. and which ones are silly before you do them. (Note: Can elaborate on instructions if child needs more).

Sentence	CHILD'S RESPONSE: First Action	Second Action	Other/ Comments
1. When you give the doll a drink of water, open the container.			
2. Put on the doll's blouse before you put on her undershirt.			
3. Give the doll a bath, but first dry her.			
4. Pour the water in the cup and give the doll a drink.			
5. Before you give the doll a bath, dry her.			
6. After you pour the water in the cup, give the doll a drink.			
7. Put on the doll's blouse and then put on her undershirt.			
8. Dry the doll after you give her a bath.			
9. Put on the doll's undershirt, next put on her blouse.			

ACT-OUT SENTENCES I

LOGICAL/ILLOGICAL SENTENCES DECLARATIVE FORM; DIFFERENT VERB

NAME: _____ AGE: yrs. ____ mo. ____ wk. ____

DATE RUN: _____ Session # _____ Adm. # _____

INSTRUCTIONS: In this game we're going to do a lot of things for the doll. I brought along a very silly friend of mine to tell you what to do. Some of the things she tells you to do are just fine--but other things are so very silly! Even though they are silly I want you to do them anyway--exactly the way she tells you to. You'll have to listen carefully each time and if you want to, you can tell me which ones are o.k. and which ones are silly before you do them. (NOTE:) Can elaborate on instructions if child needs more.

Sentence	Child's Response		
	First Action	Second Action	Other/ Comments
	_____	_____	_____
1. When you feed the doll the raisin, open the box.	_____	_____	_____
2. Brush the doll's teeth before you put toothpaste on the brush.	_____	_____	_____
3. Open the box (of raisins) but first feed the doll the raisin.	_____	_____	_____
4. Put toothpaste on the brush and brush the doll's teeth.	_____	_____	_____
5. Before you put on the doll's socks, put on her shoes.	_____	_____	_____
6. After you open the box, feed the doll the raisin.	_____	_____	_____
7. Put on the doll's socks and then put on her shoes.	_____	_____	_____
8. Brush the doll's teeth after you put toothpaste on the brush.	_____	_____	_____
	_____	_____	_____
9. Put the doll's socks on, next put on her shoes.	_____	_____	_____

ACT-OUT SENTENCES I
LOGICAL/ILLOGICAL SENTENCES DECLARATIVE FORM; DIFFERENT VERB

Name: _____ AGE: yrs. ____ mo. ____ wk.____

Date Run: _____ Session # _____ Adm. # ____

INSTRUCTIONS: In this game we're going to do a lot of things for the doll. I brought along a very silly friend of mine to tell you what to do. Some of the things she tells you to do are just fine--but other things are so very silly! Even though they are silly I want you to do them anyway--exactly the way she tells you to. You'll have to listen carefully each time and if you want to, you can tell me which one's are o.k. and which ones are silly before you do them. (Note) Can elaborate on instructions if child needs more.

SENTENCE	CHILD'S RESPONSE		
	1st Action	2nd Action	Other/Comments
1. Put the toothpaste on the brush before you brush the doll's teeth.			
2. Put the doll's shoes on, next put on her socks.			
3. When you open the box, feed the doll the raisin.			
4. Before you put on the doll's shoes, put on her socks.			
5. Put the toothpaste on the brush after you brush the doll's teeth.			
6. Feed the doll the raisin but first open the box.			
7. Put on the doll's socks and then put on her shoes.			
8. After you feed the doll the raisin, open the box.			
	99		
9. Brush the doll's teeth and put toothpaste on the brush.			

ACT-OUT SENTENCES III AND IV LOGICAL/ILLOGICAL DECLARATIVE FORM; DIFFERENT VERB

Randomized from 8 relationships with 8 connectives

Relationships:
peel banana, eat banana
dress for doll, coat for doll
cereal on spoon, feed doll
wash doll's hands, put on doll's mittens
crack peanut, feed doll
give doll a bath, dry the doll
put on doll's shoes, put on doll's boots
cook corn, feed the doll

Connectives:
and
and then
before (first and middle positions)
after (first and middle positions)
but first
next

ACT-OUT SENTENCES I
DECLARATIVE FORM; DIFFERENT VERB

Name: _____ Age: yrs. ____ mos. ___ wk. ____

Date Run: _____ Session: _____ Adm. # _____

SENTENCE	FIRST ACTION	SECOND ACTION	OTHER/ COMMENTS
1. The girl jumped the gate before she patted the horse.	_____	_____	_____
2. After the boy threw the ball he patted the dog.	_____	_____	_____
3. Before the boy jumped the gate he kicked the box.	_____	_____	_____
4. The boy kicked the rock after he patted the mouse.	_____	_____	_____
5. After the girl jumped the gate he kicked the ball.	_____	_____	_____
6. The boy patted the bird after he threw the ball.	_____	_____	_____
7. Before the girl kicked the box he jumped the gate.	_____	_____	_____
8. The girl kicked the rock before he jumped the gate.	_____	_____	_____

ACT-OUT SENTENCES II

DECLARATIVE FORM; DIFFERENT VERB

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date: _____ Session #: _____ Adm. #:_____

Sentence	First Action	Second Action
1. The boy threw the ball <u>before</u> he patted the mouse.		
2. The boy jumped over the box, <u>next</u> he sat on the rock.		
3. <u>When</u> the girl sat on the box, she patted the dog.		
4. <u>Before</u> the girl sat on the gate, she threw the ball.		
5. The boy kicked the ball <u>after</u> he kissed the bird.		
6. The girl patted the dog, <u>but first</u> she jumped over the rock.		
7. The boy threw the rock <u>and then</u> he jumped over the gate.		
8. The girl sat on the box <u>while</u> she kissed the bird.		
9. <u>After</u> the boy kicked the box, he patted the horse.		
10. The girl sat on the rock <u>until</u> she threw the ball.		
11. The boy patted the horse <u>and</u> sat on the gate.		

Comments/Other:

ACT-OUT SENTENCES II

DECLARATIVE FORM; DIFFERENT VERB

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date: _____ Session #: _____ Adm. #: _____

Sentence	First Action	Second Action
1. The girl sat on the rock <u>while</u> she threw the ball.		
2. The boy patted the mouse <u>next</u> he kicked the ball.		
3. The boy kicked the ball <u>after</u> he threw the rock.		
4. The girl threw the ball <u>but first</u> she jumped over the gate.		
5. <u>Before</u> the girl sat on the rock she kicked the box.		
6. The boy kicked the ball <u>and</u> he patted the dog.		
7. <u>After</u> the girl jumped over the gate she patted the mouse.		
8. The boy patted the bird <u>and then</u> he kissed the dog.		
9. The boy threw the rock <u>when</u> he sat on the box.		
10. The girl jumped over the box <u>before</u> she kissed the bird.		
11. The girl patted the dog <u>until</u> she threw the ball.		

Other/Comments:

ACT-OUT SENTENCES III

DECLARATIVE FORM; DIFFERENT VERB

Name:_____ Age: yrs._____mos._____wks._____

Date:_____ Session #:_____Adm. #:_____

Sentence	First Action	Second Action
1. The boy jumped over the gate <u>after</u> he patted the dog.		
2. The boy sat on the rock, <u>and then</u> he kissed the mouse.		
3. <u>Before</u> the girl threw the ball, she kicked the box.		
4. The boy patted the bird <u>before</u> he kissed the horse.		
5. <u>After</u> the girl kicked the box, she jumped over the gate.		
6. <u>When</u> the boy sat on the rock, he patted the bird.		
7. The girl threw the ball <u>and</u> kicked the gate.		
8. The girl sat on the box <u>while</u> she patted the dog.		
9. The girl kissed the bird, <u>but</u> first she kicked the rock.		
10. The boy threw the box, <u>next</u> he patted the mouse.		
11. The girl sat on the box <u>until</u> she threw the ball.		

Comments/Other

ACT-OUT SENTENCES III

DECLARATIVE FORM; DIFFERENT VERB

Name: _____ Age: yrs. _____ mos.____ wks._____

Date: _____ Session #: _____ Adm. #:_____

Sentence	First Action	Second Action
1. The boy kissed the bird and then kicked the ball.		
2. The girl patted the dog after she kissed the horse.		
3. The boy threw the ball and kicked the box.		
4. After the girl sat on the rock, she jumped over the gate.		
5. The girl sat on the horse while she patted the bird.		
6. Before the girl kicked the gate, she kissed the dog.		
7. The girl threw the ball when she patted the mouse.		
8. The boy sat on the horse, but first he jumped over the dog.		
9. The girl sat on the rock until she kicked the box.		
10. The boy threw the ball, next he sat on the rock.		
11. The boy jumped over the gate before he patted the horse.		

Comments/Other

ACT-OUT SENTENCES IV
DECLARATIVE FORM; DIFFERENT VERB

Sequence 7 & 4	First Action	Second Action
1. After the mother climbed the tree, she stood on the fence.		
2. The mother stepped on the shoe, next she dropped the bottle.		
3. The father hopped on the chair, before he pushed the truck.		
4. The father touched the rooster, but first he tickled the baby.		
5. The father tickled the cow after he hugged the rooster.		
6. When the mother kissed the rooster, she patted the baby.		
7. Before the mother tickled the baby, she touched the rooster.		
8. The father ate the apple and then he climbed on the chair.		
9. The mother stepped on the shoe while she dropped the egg.		

1. Before the father dropped the egg, he ate the cheese.		
2. The mother pushed the car and then, she ate the cheese.		
3. The mother stood on the gate after she pushed the truck.		
4. The father touched the baby while he kissed the cow.		
5. After the father tickled the rooster, he hugged the cow.		
6. The father kissed the dog, next he tickled the baby.		
7. The mother climbed the tree, but first she hopped over the gate.		
8. The mother kissed the baby before she hugged the cow.		
9. When the father pushed the truck he stepped on the shoe.		

COMPREHENSION OF QUESTIONS BEGINNING WITH WHEN/WHERE I

Name _____ Age __ yrs. ___mo. ___wk

Date _____ Session #

Instructions:

E says: I'm going to read you a story about Nancy and her Teddy Bear. Listen very carefully because I'm going to ask you some questions.

E reads the first passage (page1) and then asks S to answer the questions. It is important to get down the child's response verbatim. Listen carefully for (or lack of prepositions). Ask the questions at the end of each passage. Child looks at pictures while story is being told and still has pictures in front of him while being questioned.

Page	Passage
1	It is morning. Here is Nancy riding her bike with Teddy. They are riding through the park.
	1) WHEN ARE NANCY AND TEDDY RIDING? _____
	2) WHERE ARE NANCY AND TEDDY RIDING? _____
2+3	Oh, look what happened. Nancy fell off the bike. Oh, my! Teddy landed in the puddle.
	3) WHERE DID TEDDY FALL? _____
4	After Teddy fell, Nancy knew just what to do. She took Teddy to the laundromat and put him into the washing machine.
	4) WHEN DID NANCY PUT HIM INTO THE WASHING MACHINE? _____
5	When Teddy came out of the washing machine, Nancy put him into the dryer. The dryer kept going round and round.
	5) WHERE DID NANCY PUT TEDDY NEXT? _____
6	After Teddy came out of the dryer, Nancy put him into her arms. Teddy is all dry now. He is soft and cuddly.
	6) WHEN DID NANCY PUT TEDDY INTO HER ARMS. _____

COMPREHENSION OF QUESTIONS BEGINNING WITH WHEN/WHERE II

Name: _____ Age: yrs. ____ mos. ____ wks. ____

Date: _____ Session #: _____ Adm. #: _____

pg. 1-2 Annie is home from school helping Mommy. It is afternoon and she is in the livingroom watering plants, trying to be very careful.

1) Where are the plants Annie is watering?

2) When is Annie helping Mommy?

pg. 3-4 Oh my! Look what happened! Annie missed and the flower pot fell on the floor and broke! Annie ran to get her mother.

1) When did Annie go to get her Mother?

pg. 5-6 Mother was pretty upset. She took Annie back into the livingroom and talked to her about being more careful the next time she helped.

1) Where did Mommy take Annie?

pg. 7-8 Then Mommy and Annie went into the kitchen and Annie watched while Mommy put the plant in a new pot.

1) Where did Mommy put the plant?

pg. 9-10 After the plant was back in its place, Annie and her Mother worked together to clean up the livingroom.

1) When did Mommy and Annie clean up the livingroom?

METALINGUISTIC TASK: WORD ASSOCIATIONS TO TEMPORAL CONCEPTS

Name: _____ Age: yrs. _____ mos. _____ wks. _____

Date: _____ Session: # _____ Adm. #_____

Instructions: We're going to play a very special game with words. I'm going to say some words, and I want you to tell me others that are like the ones I just said. Listen: If I say, MOTHER, SISTER, you could say, _____,_____. Try to elicit from child any other kinship term. It he doesn't give you a kinship term, give him one and then see if you can elicit another from him. For example, you might say father, and then the child might say brother. In the training trials be very careful not to give rhyming words which are correct since children have a tendency to give you rhyming words as associations. The purpose of the training trials is to try to teach the child how to do these type of associations. You can give him all the help he needs in these training trials. In the experimental trials, try to elicit two responses.

TRAINING TRIALS

Class	Terms		Child's Response	
KINSHIP	aunt	cousin	_____	_____
FURNITURE	chair	couch	_____	_____
ANIMALS	pig	horse	_____	_____
PLAYGROUND EQUIPMENT	slide	swing	_____	_____
FRUIT (FOOD)	apple	grapes	_____	_____

EXPERIMENTAL TRIALS

PART OF DAY	morning	afternoon	_____	_____
LOCATIVES	in	on	_____	_____
PART OF WEEK	today	tomorrow	_____	_____
DAYS OF WEEK	Sunday	Monday	_____	_____
PART OF DAY	snacktime	breakfast time	_____	_____
COLOR	red	blue	_____	_____
MONTH OF YEAR	October	November	_____	_____
SEASONS	fall	spring	_____	_____
NUMBERS	four	seven	_____	_____

TIME QUESTIONAIRE

1. What is your last name? _____
2. What is your first name? _____
3. What does time mean? _____
4. How old are you? _____
5. When is your next birthday? _____
6. What month is your birthday in? _____
7. Do you have a birthday party? _____
8. What party foods do you like? _____
9. What party foods do you have? _____
10. What time do you get up? _____
11. When do you have breakfast? _____
12. What do you eat for breakfast? _____
13. What days do you go to school? _____
14. What day is today? _____
15. How do you get to school in the morning? _____
16. How long does it take? _____
17. How long do you stay in school? _____
18. Who picks you up after school? _____
19. Are you hungry when she picks you up? _____
20. How do you know when you're hungry? _____
21. When do you have dinner? _____
22. What do you eat for dinner? _____
23. What time do you go to bed? _____
24. Do you know what season or time of year this is? _____
25. What is the name of your favorite month? _____
26. Can you name the months? _____
27. What is a good summer food? _____

28. What is a good winter food? _____

29. What day do you like best? _____

30. Do you know the days of the week? _____ YES NO _____

31. Can you tell me the days of the week? _____

32. What day comes after Sunday? _____

33. What day comes after Monday? _____

34. What year is this? _____

35. Who is older(who is the oldest one) - your mother or grandmother.

_____

36. Is it morning or afternoon.(now)? _____

37. If your mommy says can you do something"in a minute" or "in an hour" which comes sooner? _____

38. Which is a long time -- a month or a year? (Which is longer?)

_____

39. Which is longer, a minute or an hour? _____

40. Which is longer, a week or a month? _____

41. What does time mean? _____

APPENDIX D

Unfamiliar Temporal Connectives:

A Test of the First-Clause-First Strategy

Joyce Weil

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THE DEVELOPMENT OF TEMPORAL CONNECTIVES: THE FIRST-CLAUSE-FIRST HYPOTHESIS

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For several years I have been interested in how children learn to talk about time. Mastering the expression of temporal relations is particularly important for children learning English, which is rich in expressions of time -- now, dawn, January, Wednesday, 1976, after dinner, and so on and on. Moreover, unlike many non-Indoeuropean languages, every English sentence must have a tense marker, whether or not the speaker is interested in making a temporal distinction.

English has four major systems for talking about time: tense, aspect, auxiliary verbs, and time adverbials. Psychological research on tense and aspect has been relatively meager; they are poorly understood, even by linguists, who disagree on the correct semantic theory for the various tenses of English. Psychologists have concentrated primarily on the temporal adverbials, on words or expressions like tomorrow, on Tuesday, after the game, when I write. The

words before and after have received the most attention from psychologists, partly because before and after seem to be the simplest signals of temporal ordering and partly because, although they appear to be antonyms, they are not equally easy to understand. For example, if A and B are two clauses describing momentary events occurring in that order, then the temporal relation between those two events can be represented in sentences as follows: (slide 1)

(1) After A, B

(2) A before B

(3) Before B, A

(4) B after A

Although these four sentences are equivalent in meaning, they are not equivalent in difficulty.

In examples (1) and (2), the events described by A and B are mentioned in the sentence in the same order they occur: I will refer to these as "forward" sentences. In examples (3) and (4), A and B occur in the opposite order from the order in which the events occur: I will refer to these as "backward" sentences. Moreover, when after is used in the first position of a sentence, it results in a "forward" sentence, but when it is used in the middle position of a sentence, it results in a "backward" sentence; conversely, when before is used in the middle position of a sentence, it results in a "forward" sentence, but when it is used in the first position of a sentence, it results in a "backward" sentence. The second slide presents the sequential description of

before and after. To summarize, before and after can both be used in such a way as to parallel the actual order in which events occur, or they can reverse the order, but, for a fixed order of events, their positions in the sentence are exactly the opposite.

Another way to describe the relation between the two clauses is grammatically. This is summarized in the third slide. One clause is called the main clause and the other the subordinate clause. The subordinate clause, which is introduced by before or after, relates the event in the main clause to a point in time; that is, the subordinate clause tells you when the event in the main clause occurs. Syntactically, main clauses are generally considered to be derivationally simpler than subordinate clauses.

In the preceding description, if A and B describe momentary events, then before and after can be used interchangeably: all four sentences mean the same thing. Yet, the experimental data from adults and children show they are not all equally easy to understand, even though before and after occur with equal frequency in the language (Kučera and Francis, 1970). In one of the earliest experiments on these two words, Clark and Clark (1968) asked adults to recall before/after sentences verbatim; they found that recall was more accurate for forward sentences than for backward sentences. However, when Smith and MacMahon (1970) presented such sentences to adults and measured how quickly they could report which event came first, they found no facilitating effect for forward sentences;

instead, they found that information in the main clause is more accessible than information in the subordinate clause. In a second study, Smith and MacMahon presented adults with these same four types of sentences, but allowed them to study the sentences as long as they needed to before they answered the question "Which came first?" With this method, they found that inspection times were shorter for sentences containing before.

Most of the subsequent studies of the processing of before and after are experiments with children, and those are the studies I want to discuss here today. For example, in a typical experiment children were asked to act out with toys the events described by such sentences as "The boy kicked the rock before he patted the dog" (Clark, 1971), or "Move the red car, before you move the blue car" (Amidon and Carey, 1972; Johnson, 1975). Most of the studies conducted with children find that forward sentences are easier than backward sentences, and that before is easier than after.

Several hypotheses have been proposed to explain the differences between before and after. Some of these accounts have raised such questions as whether the difference between before and after can be attributed to semantic markedness (Clark, 1971; Leech, 1970); others have assumed that main clauses are easier to process than subordinate clauses (Smith and MacMahon, 1970; Bever, 1970); and still others have proposed that the conceptual tasks set for the child are not equally difficult (Weil, 1970). Thus, the theoreti-

cal explanations are as diverse as are the experimental results.

The most detailed theoretical explanation of children's acquisition of temporal connectives has been proposed by Eve Clark (1971; 1973). She delineates four stages in a child's acquisition of before and after. According to Clark, in the first stage children do not understand either word; they use an order-of-mention strategy in acting out all complex temporal sentences. In the second stage, children demonstrate an understanding of before, but not after; in the third, children interpret after as though it means before; in the final stage they understand both connectives. She interprets this ordering as support for the notion that children acquire separate meaning components (or "semantic markers") of before and after hierarchically, from the superordinate component on down. The superordinate component is TIME, which is hierarchically differentiated into notions of SIMULTANEITY and SUCCESSIVENESS. SUCCESSIVENESS, in turn, is subdivided into a notion of PRIORITY: +PRIOR (the notion of "before now") precedes -PRIOR (the notion of "after now").

If such a hierarchy of semantic markers did exist, then we would expect that very young children, or children with a limited knowledge of time, should give predominantly responses that confuse SIMULTANEITY and SUCCESSIVENESS. Older children would differentiate between SIMULTANEITY and SUCCESSIVENESS, and so would be able to master the notion of "before now". And, of course, once they had mastered the notion of SUCCESS-

IVENESS, they could use a first-clause-first strategy in dealing with unfamiliar temporal concepts.

In a laboratory situation where a child has to act out two arbitrary sequences, what are some possible responses we can expect? There are three things he can do. The child can decide not to respond at all, he can act out just one of the two events, or he can act out both events. If he rejects the task, we do not try to test him, which leaves us with only two kinds of responses. Today I just want to consider the case in which the child acts out both events.

If he acts out both events, they can either be in the right temporal order or the wrong temporal order. If he is wrong, he may be using some strategy based on his previous experience with complex sentences. For example, he may use a first-clause-first strategy, a main-clause-first strategy, or he may act out both clauses at the same time. If he treats the complex sentence as if it were two simple sentences, and if he acts as if the first clause always described the first event in time and the second clause always described the second event in time, then we can say that he is following a first-clause-first strategy. On the other hand, if he has already learned that English has a way of marking an important clause -- that there is always some doodad that signals subordination -- and that he should act out the more salient clause (the main clause) first and the less salient clause second, then we can say that he is following a main-

clause-first strategy. And if he acts out both events at the same time, we can say that he is following a simultaneous strategy. Note in particular that none of these strategies requires that the child has any understanding of the meaning of the temporal connectives. In fact, all they imply is that the child understands that the experimental situation involves two events, and that the two events may be carried out in a forward order, a backward order, or simultaneously. In that case, we could expect that the child would perform identically if the connectives were nonsense instead of meaningful words.

In the first study I want to talk about, we were concerned with the question of how the whole domain of temporal adverbials develop. Before and after are only two of several connectives that a child must learn in order to master the whole system of English time adverbials; the meanings of before and after depend on their conceptual relations to other temporal connectives: and then, next, when, but first, while, until, and so on.

In this first study we tested for the development of the most common temporal adverbials: and then, next, before, after, when, and but first; two kinds of sentences were used, imperative and declarative.

Each declarative sentence had a subject noun phrase (the boy or the girl) in the first clause, which was pronominalized in the second clause; each clause contained one

of six different action verbs (pat, kick, throw, jump, kiss, or sit); and the object of the verb in each clause named one of eight different objects (toys that the children could name, such as mouse, ball, rock, gate, box, bird, dog, and cow). These words were used to construct a total of 32 different clauses, and these clauses were combined with the eight temporal connectives to form two sets of eight sentences. One set was presented at each testing session. An example of one of the declarative sentences is: The boy threw the ball before he sat on the rock.

The imperative sentences, in contrast to the declarative, contained the same verb (pick up) in every clause across all sentences. Thirty-two common toys were used to form 32 clauses that were combined with the eight temporal connectives to form two sets of eight sentences. One set was presented on each testing session.

Ninety children between the ages of three and five-and-a-half were tested individually by one of two female experimenters. The task was described to the child as a game in which he was to remember what the experimenter said and then act out everything he heard. Each child was scored as giving a correct response if he acted out the sequence exactly as indicated by the sentence instructions. Responses were classified as: (1) order-of-mention -- the child followed a strategy in which he acted out the events in the order in which they were mentioned in the sentence and ignored the order in which they occurred in time. Such a response will

be scored as an error only for the backward sentences, that is, B after A, Before B, A, and B but first A; when an order-of-mention error occurs with B after A it could be interpreted to mean that the child was using either a main-clause-first strategy or a first-clause-first strategy; (2) reversals -- the child reversed the temporal sequence in which the events were mentioned. Such responses will be scored as errors only for the forward sentences A and then B, A next B, A when B, A before B, and after A, B; when they occur with when or after, they may imply a main-clause-first strategy; (3) clause deletions -- one of the two actions described in the sentence was not performed; (4) other -- children acted out the events simultaneously, or they performed the wrong action, or they used the wrong object.

The first graph indicates the percent correct for each connective as a function of age. A reasonably orderly development of the connective emerges. Previous research has led us to expect that those connectives that fit a first-clause-first strategy would develop first, and that those connectives whose order-of-mention does not correspond to the order in which the events occur would develop more slowly. Children as young as three performed at ceiling level for three of the forward sentences: A and then B, A next B, and A before B. The three backward sentences, B but first A, Before B, A, and B after A, are the most difficult for the youngest children. However, on two forward connectives the children did not perform as

well as expected. When A, B and after A, B, both forward sentences, were significantly more difficult than the other three forward sentences. Curiously, at the age of 3-1/2 the children's performance on the backward sentence B but first A showed a distinct improvement; their performance increased from 63% to 95% correct. Performance on the forward sentence when A, B showed a much smaller increase. At age four, the children seemed to have mastered all the connectives except before B, A and B after A. It isn't until age 5 that there are no significant differences among the connectives.

Thus, one trend that emerges is that around age 3, A and then B, A next B, and A before B are the easiest sentences, when A, B and after A, B are somewhere in the middle, and the three backward sentences are the most difficult. However, by age 3-1/2, children's performance on the backward coordinating conjunction B but first A is equal to that of the forward sentence A next B, A and then B, and A before B, and is significantly better than after A, B. Comparison of the children's performance on B but first A and after A, B indicates that how children respond to these sentences cannot be attributed entirely to a first-clause-first strategy or to an inability to reverse the order in which events are mentioned.

The next table classifies the children's responses to each connective. Previous studies had led us to believe there would be few clause deletions and reversals, but in our data reversals accounted for most of the errors with after A, B and when A, B.

Reversal errors in forward connectives do not support the hypothesis that young children rely almost exclusively on a first-clause-first strategy. Perhaps some children use a first-clause-first strategy, but an equally plausible explanation is that some children use a main-clause-first strategy. The main clause of a sentence tells the child what the sentence is about; what is being asserted. The subordinate clause relates that assertion to some point or event in time. If a child uses a strategy that says "Do whatever is in the main clause first" or "Do whatever she's talking about first," then he will respond correctly more often on sentences containing before than on sentences containing after.

The next slide illustrates this point. A plus sign indicates that a particular strategy will be successful for a particular connective; negative signs indicate that if that particular strategy is used, the child will score an error on that connective. Thus, if a child uses either a main-clause-first or a first-clause-first strategy, he will perform correctly on A before B; on the other hand, if he used either one of those strategies with B after A, he will be incorrect. If we sum the number of successful strategies available to the child for each connective, it becomes apparent that A before B should be the easiest and B after A should be the most difficult, which corresponds to the empirical data. (It should be noted, of course, that second-clause-first and subordinate-clause-first strategies are also logically possible, but no one has seriously

proposed that children might tend to favor them. For one thing, second-clause-first and subordinate-clause-first strategies, taken together as above, would predict the wrong order of difficulty for the four test forms.)

The analysis in this table suggests that a child need not have any comprehension of the meanings of before and after in order to get A before B right. All he has to do is to adopt either one of two most obvious strategies. Nevertheless, we know from other research on children's spontaneous productions that by the time they are four they have had many opportunities to hear and use words like before and after, if not as temporal conjunctions, at least as temporal and spatial prepositions (Cromer, 1969). Thus, most children will have already developed the hypothesis that words such as before and after have something to do with ordering things in the spatial or the temporal domain. In order to test the hypothesis that children succeed with sentences like A before B because they happen to coincide with predominate response strategies, and thereby also test Clark's semantic feature hypothesis, it would be necessary to know how a child would deal with a completely unfamiliar term, one that he has never heard before and for which he has no semantic associations. In such a test, the sentences should be syntactically identical to those containing meaningful conjunctions.

Do young children, regardless of connective, act out sentences in the order in which they are mentioned? If a first-clause-first strategy indicates a response bias on the part of the child, then an act-out task that contains a meaningless connective should elicit a consistent pattern of responses.

Fortunately, at the same time that we were conducting the cross-sectional study, we were also conducting a mini-longitudinal study of lexical development. Fifteen children whose ages, at the onset of the study, ranged from 2;4 to 4;0 (mean age 3;1) came to the Rockefeller University Child Research Facility once a week to participate in a play group, and so were available as subjects in some studies of the development of color and temporal terms. In the course of the schoolyear, the same cycle of tests was administered to each child four times. During the third assessment period, when the children's ages ranged from 2;8 to 4;5 (mean age 3;6), we decided to introduce a nonsense word as a temporal connective.

During the first and second assessment period, the children had been acting out imperative and declarative sentences identical to the ones I described previously in the cross-sectional study. Thus, without any special instructions, we could embed a series of nonsense sentences into the regular battery. The sentences were syntactically identical to the imperative act-out sentences: there were eight sentences

of the form A bittler B; Bittler A, B; Alshem A, B; A Alshem B. Each child heard four of these sentences one week apart.

Their responses were classified in the same way as they were in the first study: order-of-mention, reversals, simultaneous and other. If, as Clark suggested, young children use a first-clause-first strategy when they do not understand a temporal connective, then meaningless connectives like bittler and alshem should elicit a consistent pattern of first-clause-first responses.

The next table presents the response strategies for each of the nonsense connectives, as well as to before and after during the first and third assessment period. However, as the table shows, responses to the nonsense connectives were divided among the three types of temporal orderings. The first-clause-first response occurred 44% of the time, the second-clause-first response occurred 35% of the time, and 21% of the time the two actions were performed simultaneously. When we compare this distribution of responses to those the same children made to meaningful connectives during their first assessment period, it becomes apparent that children had already formed some hypotheses about before and after, at least for the A before B, After A, B, and Before B, A. For example, they knew that a simultaneous

response was not appropriate for these sentences. The striking result, however, is the similarity in response patterns between the nonsense connectives and B after A at the first assessment. This result does not support the idea that children use a first-clause-first strategy when they do not comprehend a temporal connective, nor does it support the notion that they overgeneralize before to mean after. What is most striking about the B after A data on the first assessment is the high percent of simultaneous responses. It suggests that B after A was treated like a nonsense connective; the children just didn't know what to make of it. And, apparently, when they don't know what to make of a temporal connective, they generate a 45-35-20 distribution of responses. This result looks like a response bias, all right, but it is not a result that could be predicted from our theoretical analysis in Table 4.

The variety of responses to the nonsense connectives was a little bewildering. These children had been tested almost every other week with some form of a temporal comprehension act-out task. We expected that they would use an order-of-mention response predominantly. After all, that had been the response they had given most of the time, and for the majority of the test sentences it had been the correct response. Yet, the data just presented indicate that the children used all possible temporal orderings. Perhaps their thorough familiarity with temporal connective tasks led them to develop

some complex and unexpected hypotheses about the nonsense connectives.

Therefore, we decided to replicate the study. We tested an additional sixteen children, 8 whose mean age was 3;0 and 8 whose mean age was 4;6. After an initial familiarization with the experimenter, each child was asked to act out a series of 20 sentences. They were similar in form to those of the longitudinal study -- some were meaningful and some were nonsense -- except that the nonsense syllables were changed to lerbit and tomal. (This was to insure that the children would not make any phonological assimilations of bittler to before, or of alshem to after.) Two lists of 10 sentences were devised, and each child was first given one list containing 10 sentences, then a small break, and then the other set of 10 sentences. Each list was randomized with respect to the order of connectives, except that the first sentence in each list contained one of the nonsense connectives.

The next table compares the responses to the nonsense connectives of the longitudinal sample with the corresponding responses on the cross-sectional replication. Again, it is apparent that children used all the temporal orderings; the response patterns in the two studies were very similar. Thus, our fear that the earlier results from the longitudinal study might have been contaminated by overtesting was not born out.

Clark has suggested that children will use a first-clause-first strategy when they do not understand connectives such as before and after. Since neither the younger nor the older

children could have had any previous experience with the nonsense connectives (and so could not have attached any semantic features to them), we were curious to see whether there would be any age differences in response patterns. According to Clark's semantic feature hypothesis, there should be no age difference. The next table compares the response pattern of the younger children with that of the older children for both meaningful and nonsense connectives. As can be seen from the table, the older children give an order-of-mention response to the nonsense connective significantly more often than do the younger children ($z=2.12$), and give reversal responses significantly less often ($z=1.86$). Simultaneous responses were given with equal frequency, at both ages.

We were not puzzled by the frequency of the order-of-mention response, but by the fact that the older children used it significantly more often than the younger children. The differences between the two groups does not seem to fit with a semantic feature or markedness hypothesis.

The use of a first-clause-first strategy, resulting in order-of-mention responses, is not, after all, a surprising observation. It would seem to follow very naturally from some general principle of memory to the effect that it is generally easier to remember events in the order in which they occur -- whether those events are clauses or actions. There is even some evidence in the literature on memory organization that stimulus events are assigned "time tags,"

and that those tags can be used to reconstruct the order of events or to make accurate judgments about what happened first. But even if children do not assign such time tags to the events they hear described, they probably still enter those descriptions into their memory in the order in which they hear them. The point of this argument, therefore, is that the use of a first-clause-first strategy can be understood rather simply in terms of a general principle for encoding experience in memory -- an explanation that is at least as plausible as any explanation in terms of a hierarchy of semantic features associated with the connectives.

Thus, the next question we wanted to examine was the extent to which a first-clause-first strategy contributes to the child's overall performance on the temporal connectives. Both the table illustrating possible strategies for acting out complex sentences (Table 4) and our study on the development of temporal connectives (that was the first study I reported today) indicated that a child may use not only a first-clause-first strategy, but also a main-clause-first strategy. He may already have begun to form the hypothesis that "doodads" or "buzz words" in front of a clause signal something about the status of that clause within a complex sentence.

In order to examine the extent to which a first-clause-first strategy contributes to the child's overall performance we first devised a chart that shows the relations between the nonsense connectives and the meaningful connectives.

The next table illustrates this relation. Let clause$_1$

refer to the first clause the child hears spoken; clause$_2$ refer to the second clause the child hears spoken; A refer to a clause describing the first event in time, and B refer to a clause describing the second event in time then:

If a child hears a statement such as Clause$_1$ lerbit clause$_2$ and acts out clause$_1$ first, and clause$_2$ second, then he is doing what would have been a correct response to A before B;

Now, if the child hears that same statement, Clause$_1$ lerbit clause$_2$ but acts out clause$_2$ first and clause$_1$ second, then he is doing what would have been a correct response to B after A;

Similarly, if the child hears Lerbit clause$_1$, clause$_2$ and he acts out clause$_1$ first and clause$_2$ second, then he is doing what would have been a correct response for After A, B;

And, if he hears Lerbit clause$_1$, clause$_2$ but acts out clause$_2$ first and then clause$_1$, then he is doing what would have been a correct response to Before B, A.

In the next table, we examined the contribution of the sentential position of these buzz words to the children's response patterns. For the younger children, it appears that order-of-mention responses are used almost as frequently as reversal responses regardless of the position of the nonsense connective. On the other hand, for the older children, order-of-mention responses were given almost three times as frequently as were reversal responses.

Moreover, the percentages for the older group seem to give a clear ordering of response strategies as a function

of sentential position of the nonsense connective. The next table summarizes these experimental observations. As you can see, the resulting ordering for the temporal connectives is roughly the same as found in other studies with young children. The remarkable aspect is that the ordering was constructed entirely from data based on nonsense connectives. No semantic feature theory nor syntactic complexity theory can account for an ordering derived from nonsense syllables.

My disagreement with Eve Clark's approach to this problem is not at the level of data. Most of the general observations on which she based her theoretical argument -- in particular, the tendency for children to use a first-clause-first strategy and for before to appear earlier in their speech -- most of those observations have been supported in my own data. The point of disagreement concerns what explanation should be given for those observations. Clark feels that they count as evidence for the successive acquisition of a hierarchy of semantic features. Yet there could be no such semantic features associated with nonsense words like lerbit or tomal. How, then, do we account for the fact that the children's responses to these meaningless connectives are so similar to their responses to meaningful connectives like before and after?

If we cannot account for such similarities on the basis of a hierarchy of semantic features, then the most obvious alternative explanation would seem to be in terms of syntactic

features. That is, we obviously do not want to say that the children know nothing about before and after, but what they know is not a hierarchy of semantic features. And at least part of what they do know is that these words signal a special kind of syntactic relation between two clauses.

The implication for a syntactic theory of acquisition of temporal conjunctions is that the syntactic structure of the sentence provides significant information for the older child but plays no discernible role in the response strategy for the younger child.

Older children were so much more aware whether the nonsense connective was in the initial or middle position. Somewhere during their linguistic development, they begin to realize that buzz words signal subordination, and that when a buzz word comes first they should be careful about order-of-mention responses. Older children's production data clearly show that they use before as a temporal conjunction much more frequently than they use after. However, this mastery of before in the children's productions is less a semantic accomplishment than a syntactic one -- they are learning one of the simplest syntactic devices for joining two sentences into one.

The core of the time concept is relatively simple, growing out of the child's experience of successive moments. It is evident from studies describing the child's early perceptual development that he has an "idea" about the present moment -- of now, of the notion of earlier than now

and later than now, and he has also appreciated the idea that two events can occur at the same time. Thus, the experimental data on children's acquisition of time language -- which stresses a relatively late development -- suggests that the complexity of the time concept lies in its linguistic expression, rather than its conceptual core.

We believe that there are two important stages in the child's linguistic acquisition of temporal conjunctions. In the first stage, which happens early in the child's linguistic development, he acquires the idea that there is a certain class of words that belong to a semantic domain called time. Thus, during this stage, which occurs rather quickly, the child learns that words such as before, after, first, last, when, while, earlier, later, etc. have something to do with time -- perhaps even with some notion of sequence.

During the second stage, which may last a very long time, perhaps five years or more, the child must learn to map these words in his temporal lexicon onto both his conceptual understanding and his growing syntactic competence. I do not want to go into detail about the kinds of linguistic distinctions that an adult speaker might need to make in order to use temporal conjunctions, I just want to emphasize the point that there are no psychological grounds for assuming that a child's knowledge of temporal relations is hierarchically structured.

Examples of Temporal Sentences

A and B are clauses describing events occurring in that order:

(1) After A, B: After the boy kicked the box, he patted the horse.

(2) A before B: The boy kicked the box before he patted the horse.

(3) Before B, A: Before the boy patted the horse, he kicked the box.

(4) B after A: The boy patted the horse after he kicked the box.

TABLE 1

SEQUENTIAL DESCRIPTION OF BEFORE/AFTER [1,2]

	BEFORE	AFTER
Order spoken is the order of occurrence "Forward Sentence"	A before B	After A, B
Order spoken is reverse of order of occurrence "Backward Sentence"	Before B, A	B after A

TABLE 2

GRAMMATICAL DESCRIPTION OF BEFORE/AFTER [1,2]

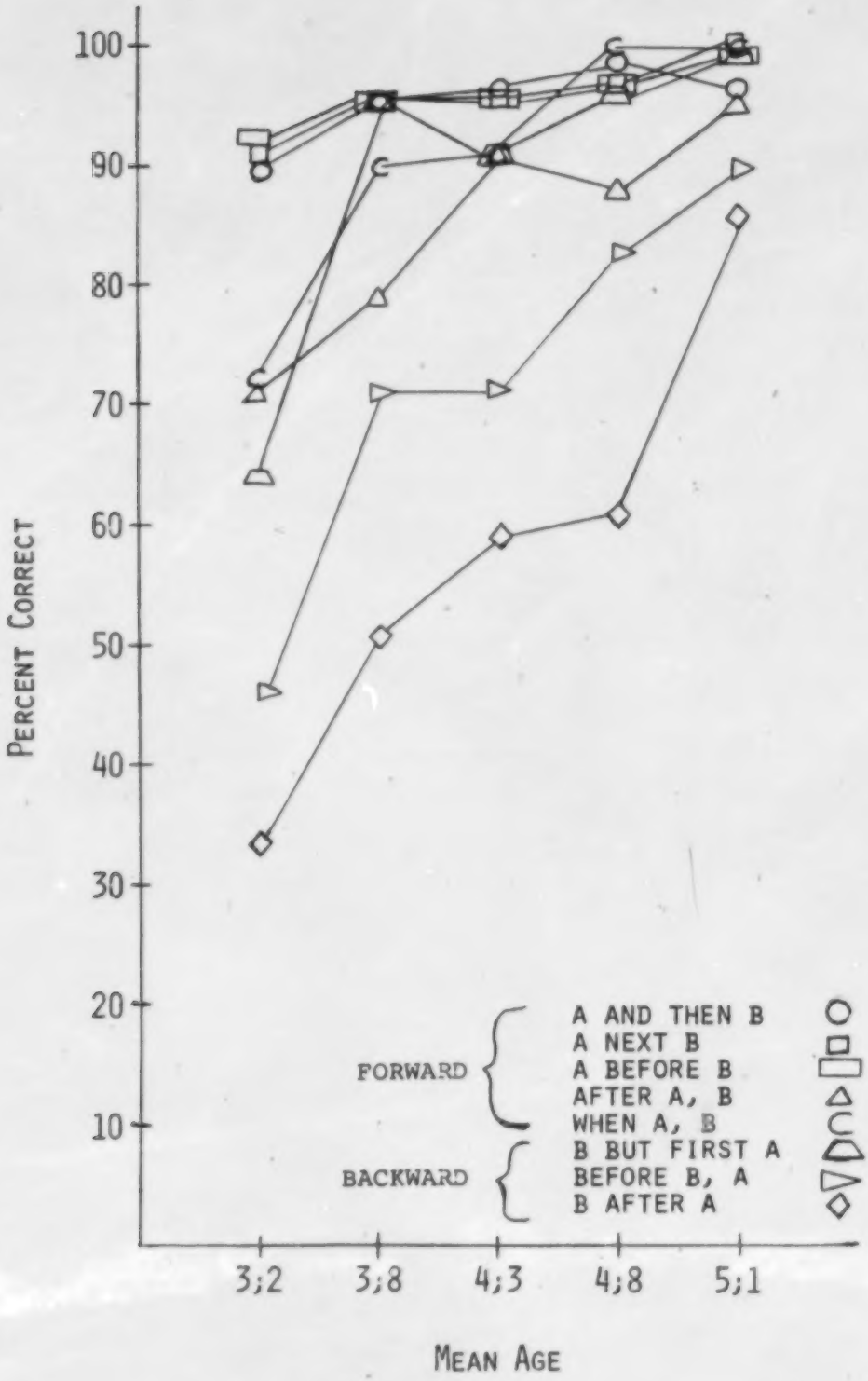
	BEFORE	AFTER
Main clause is spoken first	A before B	B after A
Main clause is spoken second	Before B, A	After A, B

[1] A represents the clause describing the event which occurred first. B represents the clause describing the event which occurred second.

[2] Underlined clause is the main clause.

STUDY I

IMPERATIVE AND DECLARATIVE SENTENCES COMBINED



Study I: Development of Temporal Connectives

Classification of Responses as a Function of Connective and Age[1]

	Connective / Age	Order-of-Mention			Reversal			Simultaneous			Deletion			Other		
		3-3½	3½-4	4-4½	3-3½	3½-4	4-4½	3-3½	3½-4	4-4½	3-3½	3½-4	4-4½	3-3½	3½-4	4-4½
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Forward	A and then B	90	96	97	9	2	2	0	0	0	0	3	2	2	0	0
Forward	A next B	92	96	97	3	2	3	2	2	0	2	0	0	0	1	0
Forward	A before B	93	96	96	6	0	5	0	2	0	2	3	0	0	0	0
Forward	After A, B	72	80	92	17	12	9	1	2	0	8	0	0	3	2	0
Forward	When A, B	56	39	46	18	4	7	17	51	44	7	5	2	3	2	2
Backward	B but first A	26	3	3	63	96	93	1	0	0	9	0	3	1	2	0
Backward	Before B, A	43	23	24	47	67	72	3	1	2	7	9	3	2	1	0
Backward	B after A	57	44	31	31	50	60	0	0	4	9	2	4	4	4	0
	All connectives combined	66	60	61	24	29	31	3	8	7	4	2	1	2	2	0

[1] Declarative and Imperative Sentences Combined

TABLE 4

POSSIBLE STRATEGIES FOR ACTING OUT COMPLEX SENTENCES: GIVEN S MAKES TWO RESPONSES[1]

Sentence Type	Strategy: First-Clause-First	Strategy: Main-Clause-First	Total Correct
A before B	+	+	2
After A, B	+	-	1
Before B, A	-	+	1
B after A	-	-	0

1 "+" sign indicates a correct strategy for a particular concept

"-" sign indicates an incorrect strategy for a particular concept

LONGITUDINAL STUDY

Classification of Responses to Connective[a]

(in percent)

	Order-of-Mention		Reversal		Simultaneous		Other	
	Asses.I	Asses.III	Asses.I	Asses.III	Asses.I	Asses.III	Asses.I	Asses.III
A Before B	77	90	23	7	0	0	0	3
After A, B	73	77	20	20	7	3	0	0
Before B, A	57	30	37	70	3	0	3	0
B After A	43	53	37	43	20	3	0	0
Total	63	63	29	35	8	2	1	1
Nonsense	--	44	--	35	--	21	0	0
And	30	23	17	27	53	50	0	0

[a] N = 15
Mean Age Assessment I = 3;1
Mean Age Assessment III = 3;6

Classification of Responses to Nonsense Connectives

(in percent)

Sample	Mean Age	Order-of-Mention	Reversal	Simultaneous	Other
Longitudinal N = 15 (mean age 3;6)	3;6	44	35	21	0
Cross-Sectional N = 16 (mean age 3;9)	3;9	48	24	23	4

NONSENSE CONNECTIVE TASK

CROSS-SECTIONAL REPLICATION[a]

Classification of Responses by Connective

(in percent)

	Order-of-Mention		Reversal		Simultaneous		Other	
	Young	Old	Young	Old	Young	Old	Young	Old
A Before B	50	94	31	0	19	6	0	0
After A, B	50	88	13	6	25	6	13	0
Before B, A	56	25	31	75	6	0	6	0
B After A	44	19	44	69	13	13	0	0
Total	50	56	30	38	16	6	5	0
Nonsense Conn.	41	58	30	17	22	25	8	0
And	41	56	28	0	28	44	3	0

[a] Young Group N = 8, mean age 3;0
Old Group N = 8, mean age 4;6

RELATION OF NONSENSE TO MEANINGFUL CONNECTIVES

If a child hears:	And if he does:	Then his response would be correct for:
Cl_1 lerbit Cl_2	Cl_1, Cl_2	A before B
	Cl_2, Cl_1	B after A
Lerbit Cl_1, Cl_2	Cl_1, Cl_2	After A, B
	Cl_2, Cl_1	Before B, A

[a] Cl_1 = first clause spoken; Cl_2 = second clause spoken

[b] A = first event in time; B = second event in time

NONSENSE CONNECTIVE TASK

Cross-Sectional Replication

Classification of Responses as a Function of Age and Position of Connective

(in percent)

Position of Connective	Young Group		Old Group	
	Order-of-Mention	Reversal	Order-of-Mention	Reversal
Initial	44	31	50	22
Medial	34	31	66	13

EXPERIMENTAL OBSERVATIONS

When the child heard:[a]	What he did was:	Which would have been correct for:[b]
Cl_1 lerbit Cl_2	Cl_1, Cl_2 66% of the time	A before B
Lerbit Cl_1, Cl_2	Cl_1, Cl_2 50% of the time	After A, B
Lerbit Cl_1, Cl_2	Cl_2, Cl_1 22% of the time	Before B, A
Cl_1 lerbit Cl_2	Cl_2, Cl_1 13% of the time	B after A

[a] Cl_1 is the first clause spoken; Cl_2 is the second clause spoken.

[b] A is the first event in time; B is the second event in time

Number of Responses to Nonsense Connectives as a Function of Order of Presentation

	Responses							
	Order-of-Mention		Reversal		Simultaneous		Other	
	Young	Old	Young	Old	Young	Old	Young	Old
1st presentation	2	4	2	1	1	3	3	0
2nd presentation	2	5	2	1	3	2	1	0
3rd presentation	4	4	1	1	2	3	1	0
4th presentation	3	5	2	2	3	1	0	0
5th presentation	1	5	4	3	3	0	0	0
6th presentation	5	5	2	1	1	2	0	0
7th presentation	3	5	4	1	1	2	0	0
8th presentation	5	4	2	1	1	3	0	0
Total Set 1	11	18	7	5	9	9	5	0
Total Set 2	14	19	12	6	6	7	0	0

NONSENSE CONNECTIVE TASK

Cross-Sectional Replication

Classification of Responses as a Function of Performance Level on Meaningful Connectives

Classification of Responses to Nonsense Connectives (in percent)

Performance Level	Order-of-Mention	Reversal	Simultaneous	Other
High Scorers (N = 4)	69	13	19	0
Low Scorers (N = 4)	41	19	38	3

APPENDIX E

A Comparison of Young Children's Comprehension and Memory for Statements of Temporal Relations

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A COMPARISON OF YOUNG CHILDREN'S COMPREHENSION & MEMORY FOR STATEMENTS OF TEMPORAL RELATIONS[1]

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Imagine the following scene. A young child is seated in a small chair, wearing earphones and talking into a microphone. In the earphones a lady's voice says: "Rub your stomach before you scratch your back." He looks at the adult in the room and attempts to repeat the sentence. He has just learned that if he wears the earphones the adult in the room cannot hear the sentences. This fact appeared to be crucial in persuading the child to repeat a series of sentences. After playing this game for six sentences, he is switched to a game somewhat like Simple Simon. Now, he must act out what the lady says.

What is going on, of course, is a study comparing a child's ability to remember statements and his ability to comprehend them. The type of statements we were interested in were complex sentences conjoined by a temporal connective. In the study to be reported here, we are concerned with the adverbials before and after. Before and after have received the most attention by psychologists, partly because they appear to be antonyms, yet are not equally easy to understand. For example, if A and B are clauses describing events occurring in that order, then the temporal relation between those events can be described by any one of the four sentence types in Table 1.

In (1) and (2), A and B are mentioned in the sentence in the same order as the events occur; we will refer to these as "forward" sentences. In (3) and (4), A and B

Table 1 Sequential and Grammatical Types of Complex Sentences

	Main Clause First	Subordinate Clause First
Forward Sentences	(1) A before B	(2) After A, B
Backward Sentences	(3) B after A	(4) Before B, A

are mentioned in the opposite order from the order in which the events occur: we will refer to these as "backward" sentences.

The relation between the two clauses may also be described in terms of their grammatical status. In (1) and (3) the main clause precedes the subordinate clause; in (2) and (4) the subordinate clause has been proposed. Semantically, the subordinate clause anchors the time of the event in the main clause; that is, it tells when the event in the main clause occurs. Syntactically, main clauses (which can stand alone) are considered derivationally simpler than subordinate clauses.

If A and B describe momentary events, then sentences (1) and (4) can be used interchangeably: all four sentences describe the same temporal relation. Yet, experimental data from adults and children show they are not all equally easy to understand, even though before and after occur with equal frequency in the language (Kučera and Francis, 1970). For additional references and general background see D'Arcais (this volume).

In a laboratory situation such as the one just described where a child has to act out two arbitrary sequences, what are some possible responses we can expect? There are three things the child can do: he can decide not to respond at all, he can act out just one of the two events, or he can act out both events. If he rejects the task, we do not try to test him, which leaves us

with only the last two kinds of responses.

If he acts out both events, they can either be in the right temporal order or the wrong temporal order. If he is wrong, he may be using some overly simple strategy based on previous experiences with complex sentences. For example, if he treats the complex sentence as if it were two simple sentences, and if he acts as if the first clause always described the first event in time and the second clause always described the second event in time, then he is following what we will call a first-clause-first strategy. On the other hand, if he has already learned that English has a way of marking an important clause - that there is always some marker that signals subordination - and that he should act out the more salient clause (the main clause) first and the less salient clause second, then he is following what we will call a main-clause-first strategy.

If a child uses a first-clause-first strategy, he will perform correctly on the forward sentences but not on the backward sentences. If he uses a main-clause-first strategy, he will perform correctly on those sentences conjoined with before. Thus, if a group of children use both the main-clause-first and the first-clause-first strategies, they will respond correctly most often to forward sentences containing before and least often to backward sentences containing after.

Table 2 Possible Strategies for Acting out Complex Sentences: Given 3 males two Responses*

Sentence Type	Strategy: First-Clause-First	Main-Clause-First	Total Correct
(1) A before B	+	+	2
(2) After A, B	+	-	1
(3) B after A	-	-	0
(4) Before B, A	-	+	1

* "+" sign indicates a correct strategy for a particular sentence type
"-" sign indicates an incorrect strategy for a particular sentence type

Table 2 illustrates this point. If we count the number of successful strategies available for each sentence-type, it becomes apparent that A before B should be the easiest and B after A the hardest. However, neither the use of a first-clause-first strategy nor the use of a main-clause-first strategy implies that the child has any understanding of the meaning of the temporal connectives.

If our hypothetical child acts out only one event, we obviously cannot ask which came first, but we can ask which clause described the one event that he acted out. His response may reflect a primacy effect ("act out the first clause"), a recency effect ("act out the last clause"), or a saliency effect ("act out the main clause").

Note that the kind of analysis just described for the sentence comprehension task can also be applied to a sentence repetition task. The child can decide not to respond at all, can repeat just one of the clauses, or can repeat both clauses. If he repeats both clauses, it can either be an exact copy of the input sentence, a meaning-preserving paraphrase of the input sentence, or an incorrect repetition. An incorrect repetition might contain erroneous substitutions of the connective, omission of the connective, or a sentence reversal - repetition of the second clause first.

If our hypothetical child repeats only one clause, it may indicate an overload of his immediate memory. In that case, his response may reflect a primacy effect ("repeat the first clause heard"), a recency effect ("repeat the last clause heard"), or a saliency effect ("repeat the main clause").

Although several comprehension studies, both by the present investigators and by others, have reported errors of clause deletions or clause reversals, none of these studies have related such errors to an independent measure of the child's ability to recall complex sentences. To what extent does a child's recall of a complex sentence determine his comprehension performance? We found much speculation but little experimental work on the interaction between children's memory capacity and their performance on sentence comprehension. Therefore, we compared the same child's ability to repeat a temporal statement and his ability to understand it.

We tested 72 children, 36 lower socio-economic black children and 36 middle-class white children, whose ages ranged from 3 to 6 years. Thus, there were 12 children in each of six age groups.

Each child heard, on two separate occasions, a series of imperative sentences.[2] For half of the sentences, the children were instructed to "Do what the lady tells you to do; just the way she tells you to do it" (act-out test of comprehension). For the other half of the sentences, the children were told: "Say exactly what the lady says; just the way she says it" (sentence-repetition test of immediate memory).

Audio tapes were devised from an initial set of clauses. Each clause contained one action verb such as rub, bend, wiggle, shake, and one noun phrase containing mostly names of body parts. Each child's score is based on eight act-out sentences and eight repeated sentences.

COMPREHENSION RESULTS

Each child was scored as giving a correct response if he acted out the sequence exactly as indicated by the sentence instructions. Errors were classified as: (1) first-clause-first - the child followed a strategy in which he acted out the events in the order in which they were mentioned in the sentence and ignored the order in which they occurred in time; (2) reversals - the child reversed the temporal sequence when a first-clause-first strategy would have been appropriate; (3) clause deletions - one of the two actions described in the sentence was not performed; (4) others - children acted out the events simultaneously, performed the wrong action, or used the wrong object.

Figure 1 shows the percentage of correct responses as a function of age for each connective; since there were no clear differences in the results from black and white subjects, only the pooled results are presented. The figure shows some developmental ordering of the connectives at the youngest and oldest age groups, but on the whole it looks as if all the connectives are developing at about the same time. These results bewildered us. Previous research had led us to expect that some connectives would be mastered before others.

Table 3 shows the types of response errors the children made. Neither the first-clause-first errors nor the

Figure 1 Black and White Comprehension

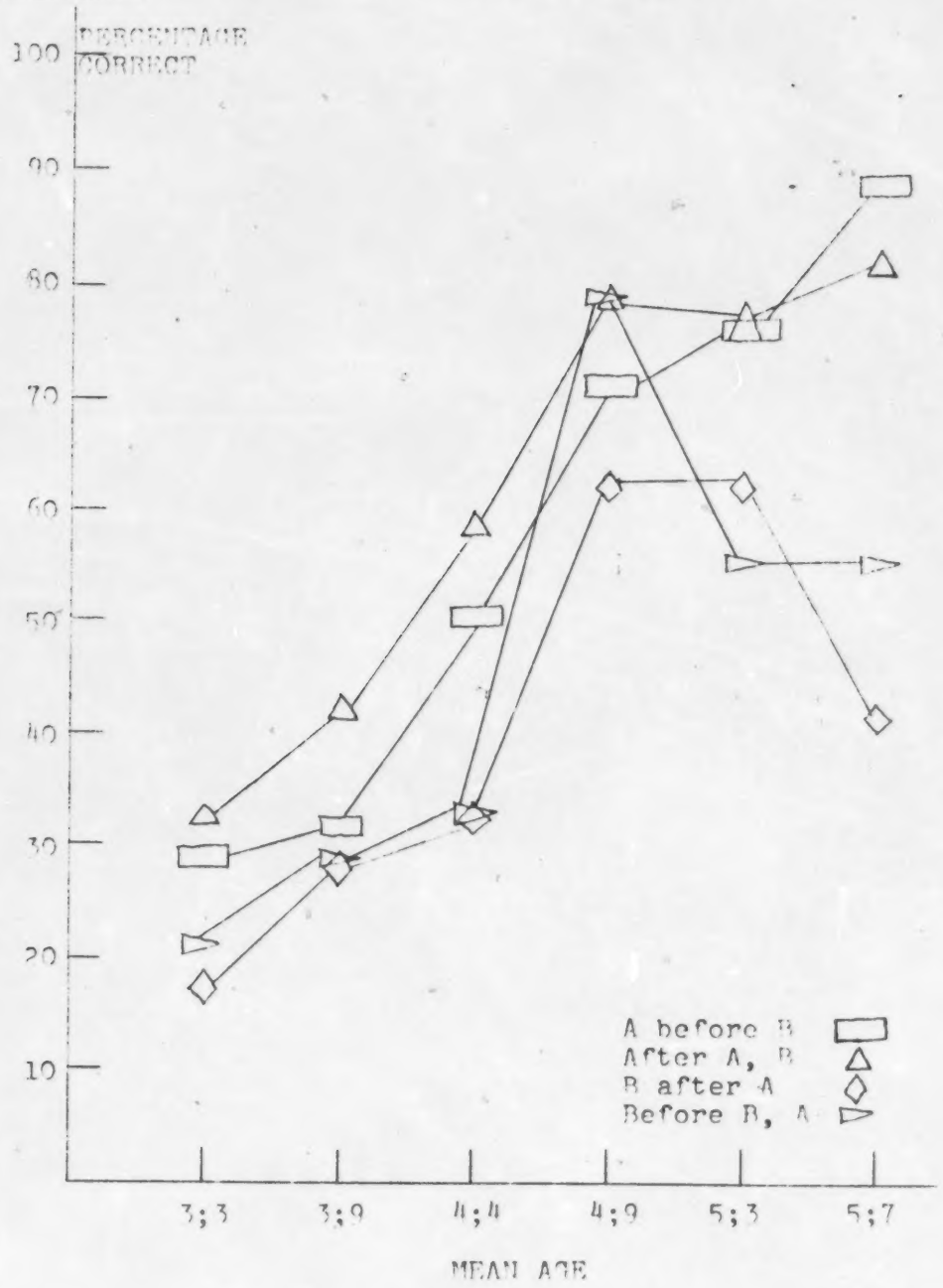

Table 3 Types of Errors by Age and Sentence Type (in percents)

Sentence Type	First-Clause-First[a]	Error Responses: Reversal[b]	Deletions	Other
Age				
I 3-3½ yrs	21	8	3	6
II 3½-4 yrs	23	15	2	2
III 4-4½ yrs	24	15	1	0
IV 4½-5 yrs	14	5	[illegible]	1
V 5-5½ yrs	11	6	7	3
VI 5½-6 yrs	20	4	8	0

[a] First-Clause-First errors are only possible for Before B, A and B after A.

[b] Reversal errors are only possible for A before B and After A, B.

reversal errors indicated any developmental trend; the oldest children were still making as many of those errors as the youngest children. Clause deletions, however, did show a developmental trend. The youngest group showed many clause deletions; on 38% of the test sentences, one of the two actions was simply not performed. The number of clause deletions dropped to 20% for the next older group and to 10% for the next. The three oldest groups showed a few clause deletions, but not enough to reveal a pattern. Since these deletions showed the only clear developmental trend, we decided to analyze them more carefully, and we will limit our remaining discussion to that analysis. We were able, we think, to show a consistent difference in the difficulty of the connectives using only these deletion data, but the analysis is more complicated than the usual percentage correct measure and must be explained in some detail.

ELETION ANALYSIS

Since the main clause was first in half of the *before* and *after* sentences and the subordinate clause was first in the other half, we can ask whether the deletions occurred primarily for the first or the second clause, and primarily for the main or the subordinate clause. This analysis is summarized in Table 4. From the marginal totals it is obvious that both variables had an effect. The fact that the first clause was deleted 41 times vs. 29 deletions of the second clause indicates a *recency effect*; the fact that the main clause was deleted only 19 times vs. 51 deletions of the subordinate clause indicates a *saliency effect*. The two effects appear to be independent. Therefore, we tried to tease them apart and to estimate their relative importance.

Table 4 Deletions in Comprehension: Groups I, II, III
All Connectives

	Main Clause	Subordinate Clause	Totals
First Clause	13	28	41
Second Clause	6	23	29
Totals	19	51	70

But first we should review the meanings of these two effects. The saliency effect - more deletions of the subordinate than of the main clause - can be explained at several levels of theory. At the linguistic level, one might argue that subordinate clauses are more difficult for young children because subordination is a complicated grammatical construction. At a logical level, one might argue that the subordinate clause is presupposed, whereas the main clause is asserted, and that young children understand the task in terms of what is asserted rather than what is presupposed. At a pragmatic level, one might argue that the main clause is usually the focus when such sentences are used in ordinary language, and that the subordinate clause is simply a way to relate this new information to information that the listener already has; young children may not understand that this usual way of speaking has been over-ridden by the demands of the experimental tasks.

Each of these accounts could be supported with a great deal of theoretical justification, but since the data provide no way to choose among them, we can do little more than assume that they all may be true. Whatever the reason, the main clause seems more salient to young children, so they are less likely to omit the action it demands than to omit the action demanded by the less salient subordinate clause. It is worth noting, however, that in order to show the saliency effect, a child must understand the sentences sufficiently well to recognize which clause is subordinate.

The recency effect, on the other hand, seems simpler psychologically, since many studies of immediate recall have indicated large recency effects in the recall of meaningful prose. We need merely assume, therefore, that these two-clause sentences overload the immediate memory of the youngest children, and that the second clause, having been heard most recently, is more likely to be remembered and acted out.

If the recency effect is simply a matter of immediate memory failure, it should be possible to estimate its contribution to the total pattern of deletions by examining the children's deletions on the sentence repetition task, which is an independent test of the children's memory for two-clause sentences. These results are presented in Table 5.

Table 5 Deletions in Imitation: Groups I, II, III
All Connectives

	Main Clause	Subordinate Clause	Totals
First Clause	37	39	76
Second Clause	10	13	23
Totals	47	52	99

Note that there are even more deletions in the sentence repetition task than in the comprehension task, by 99 to 70. If comprehension tasks require a child to say the sentence to himself as he is acting it out, this difference will be difficult to explain, because correct performance on the comprehension task would involve

both immediate memory for the sentence and correct execution of the actions it describes. It seems, therefore, that comprehension does not involve verbatim memory for the sentences, but that the child translates the sentences into some nonlinguistic form that is easier for him to remember; he uses that nonlinguistic representation to guide his performance. Apparently it is more difficult for the child to remember verbatim or to regenerate the verbatim linguistic form from this nonlinguistic representation than it is for him to act on it.

Whatever the reason for the greater number of deletions in imitation, the pattern of errors has clearly changed. Table 6 compares these two patterns; the data are converted into percentages to make the comparison easier. The comprehension data show both a recency and a saliency effect; the imitation data show only a recency effect. This suggests that we might be able to obtain a direct estimate of the saliency effect, uncontaminated by recency, if we could somehow subtract the imitation data from the comprehension data.

Table 6 Proportion of Deletions

	COMPREHENSION:			IMITATION:		
	Main	Subord	Totals	Main	Subord	Totals
First	19	40	59	37	40	77
Second	8	33	41	10	13	23
Totals	27	73	100	47	53	100

We will assume that on any given sentence, a child can delete a clause because of a failure of immediate memory or because he focusses on the more salient clause, but not both. Thus, the problem is to determine what fraction of the time one cause is at work and what fraction of the time the other is.

Let p(F) represent the probability of deleting a clause due to immediate memory failure and p(S) represent the probability of deleting a clause because the child is focussing only on the more salient clause. If we consider only those sentences where a deletion has occurred,

then the above assumptions can be represented by equation (1):

$$(1) \qquad p(F) + p(S) = 1$$

If we let $p(D_1)$ represent the probability of deleting the first clause, then

$$(2) \qquad p(D_1) = p(F) \times p(F_1/F) + p(S) \times p(S_1/S)$$
$$= p(F) \times p(F_1/F) + (1-p(F)) \times p(S_1/S)$$

where $p(F_1/F)$ is the conditional probability of forgetting the first clause and $p(S_1/S)$ is the conditional probability of not focussing on the first clause.

If it is assumed that deletions occur in the imitation task only because of immediate memory failure (that is, that $p(S) = 0$), then by applying (2) to the imitation data (Table 6) we get:

$$(3) \qquad p(F_1/F) = .77$$

With .77 as an estimate for $p(F_1/F)$, application of (2) to the comprehension data produces:

$$(4) \qquad p(F) \times .77 + (1-p(F)) \times p(S_1/S) = .50$$

Since we assume that only subordinate clauses are non-salient and since exactly half of the subordinate clauses appeared in the first position, we have:

$$(5) \qquad p(S_1/S) = .50$$

Accordingly, substituting (5) into (4) and rearranging the terms, we get:

$$(6) \qquad p(F) = \frac{.50 - .50}{.77 - .50} = .33$$

and from (1)

$$(7) \qquad p(S) = .67$$

In other words, twice as many deletions are attributable to the saliency effect as are attributable to the recency effect, according to this hypothesis. That would mean that 47 of the 70 deletions on the comprehension task were attributable to saliency, and only 23 to recency.

Next, we tried to break the deletion data down by age groups to see whether the value of p(F) decreases with age. There is no indication of an age trend, but the picture is not really clear. There are enough deletions in the youngest group to permit an estimate, and the value obtained is 0.32, which is essentially the same as that for all three groups combined. If the second and third groups are combined, they give the estimate 0.31, but there are not enough observations to permit meaningful estimates for these groups separately. On the basis of the present data, we are forced to assume that the relative contributions of short term memory and clause saliency do not change with age. The total number of deletions decreases with age, but when deletions do occur, they follow the same pattern at all ages - at least for the ages and sentence types used in the present study.

We then looked to see whether our estimate for p(F) would show any black/white differences. The black children made 56 deletions in imitation and only 28 deletions in comprehension, whereas the white children made an equal number of deletions in imitation and comprehension, 43. The estimated value of p(F) obtained for the black children is 0, so, under our assumptions, no errors in their comprehension data were attributable to failure of immediate memory. On the other hand, the estimated value of p(F) for the white children was .68; twice as many of their errors were due to failure of immediate memory as were due to the saliency effect. We speculate that the white children may have placed more reliance on repeating the sentence to themselves as a guide to acting it out, and since sentence repetition leads to a memory effect, this is the effect that dominates in their comprehension data.

Since much controversy about <u>before</u> and <u>after</u> centres around which connective is easier or develops earlier, another way to break the data down is according to the connectives <u>before</u> or <u>after</u>. Following the same argument as before, we obtain p(F) = 0.13 for <u>before</u> and p(F) = 0.63 for <u>after</u>. That is to say, when a clause is deleted from a <u>before</u> sentence, it is almost seven times as likely to be a saliency effect as to be an immediate memory effect, whereas when a clause is deleted from an <u>after</u> sentence, it is almost twice as likely to be a memory effect as a saliency effect.

This rather striking difference suggests the following hypothesis. The children understand <u>before</u> well enough

to form some internal memory representation of the temporal relation between the events that are described by the *before* sentences, and therefore when they delete the action described in the subordinate clause it is probably because they take the subordinate as already given. On the other hand, they do not understand *after* very well, and therefore are more often thrown back on verbatim recall of the sentence they heard, in which case they are more likely to recall only the clause heard more recently.

There has also been considerable controversy about the importance of the order of the clauses relative to the order of the actions that the child must perform. Since it has been frequently reported that forward sentences are easier, both for children and adults, than backward sentences are, we computed p(F) to see whether there are any differences between forward and backward sentences with respect to the deletion data.

The same computations now yield p(F) = 0.19 for the forward sentences and p(F) = 0.48 for the backward sentences. That is to say, when a clause is deleted from a forward sentence, it is four times as likely to be a saliency effect as to be a memory effect, whereas saliency and memory contribute about equally to deletions from the backward sentence. This difference is not as striking as in the case of *before* vs. *after*, but it is consistent with the hypothesis that when children understand the sentences their deletions tend to follow the saliency pattern, and that when they do not understand the sentence, their deletions tend to follow the memory pattern.

If this hypothesis is correct, then the p(F) values that we have computed can be regarded as indicating, not only the relative weight of immediate memory errors, but also the difficulty the child has in understanding the sentences. We can, taking this view of p(F), arrange these results as in Table 7.

Table 7

p(F)	*After* A, B	*Before* B, A	Averages
B after A	0.63	0.48	0.55
A before B	0.19	0.13	0.16
Averages	0.41	0.30	(0.33)

The method of analysis used here required (at least) pairs of connectives in order to estimate p(P), and each cell of the matrix gives the p(P) value computed for the pairs indicated by the row and column headings. The row and column averages are legitimate if we regard p(P) as a measure of difficulty. The precise values of these averages are of little interest in any case; what is of interest is the order of difficulty that they reveal:

Hardest:	B after A	0.55
	After A, B	0.41
	Before B, A	0.39
Easiest:	A before B	0.16

In view of the number of assumptions involved in reaching this result, it is comforting (and perhaps lends support to the assumptions) that this ordering is roughly the same as that found in other studies. The remarkable aspect is that the ordering was constructed entirely from data on deletions and under conditions where the children's data did not show consistent differences in the difficulty of these connectives as measured by the percentages of correct performances in the comprehension data. Note that we could not have done such an analysis without both measures of comprehension and recall.

Footnotes

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[2] The complete study investigated six different connectives, only four of which are reported here. Twelve different audio tapes were devised for the six connectives, counter-balancing order of connectives as well as connective and clause combinations. Thus, each child heard a total of 24 imperative sentences composed from an initial set of 24 clauses: twelve sentences, six act-out and six sentence repetitions, at each of two testing sessions.

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APPENDIX F

Lexical Development:

A Mini-longitudinal Approach

Joyce Weil

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The author wishes to thank George A. Miller and William Hirst for helpful comments.

tively (using a two-tailed t-test, $t_9 = 1.47$, $p < .10$). Although the difference was not significant, it was in the appropriate direction. "The second hypothesis was that an order-of-mention strategy would be used by younger children" (*ibid*). In other words, forward constructions will elicit fewer errors than backward constructions. Our studies showed that, over-all, forward constructions did indeed elicit fewer errors than the backward constructions, 22% vs. 50%, respectively (using a two-tailed t-test, $t_9 = 4.02$, $p < .01$). Finally, Clark predicted that the position of a connective within a sentence should make no difference. Errors on *X before Y* and *Y after X* combined were not significantly different from errors on *before Y, X* and *after X, Y*, 38% vs. 35%, respectively (using a two-tailed t-test, $t_9 = .59$, $p > .5$).

We did not replicate the error percentages found by Clark (the children in our sample were younger than Clark's), but the relative pattern of results are identical: (1) forward sentences are easier than backward; (2) *before* is easier than *after*; (3) position of a connective within a sentence does not affect the results. Thus, when the four assessment periods were treated as though they were four cross-sectional samples, Clark's predictions were confirmed. This confirmation is important, because it means that our data are probably representative of the kind of evidence on which Clark based her hypothesis.

Longitudinal analysis. Clark also analyzed the error patterns for individual children. She classified children in stage A if they made one or less errors out of a possible four on the forward constructions, and three or more out of a possible four on the backward constructions. Children were in stage B_1 if they made one or less errors on both forward constructions and on the construction *before Y, X*; children were in stage B_2 if they made one or less errors on both *before* constructions and three or more errors on both *after* constructions. Children in stage C made one or less errors out of a possible four on all four constructions.

We did a similar analysis of response patterns for each individual child at each assessment period, with the exception that two correct responses out of a possible two were needed for a construction to be scored correct; one or more errors on a construction was scored as incorrect. Table I shows the response patterns for each child at each assessment. For example, at the first assessment, child #1 was correct only on *X before Y*, which is coded as 1000 (see footnote to Table I). Since there are four constructions, each of which can be acted out correctly or incorrectly, there are 16 possible response patterns. Only four of these are predicted by Clark's stage descriptions. However, out of 16 possible response patterns, 13 were used at least once. And out of 40 observations (10 Ss by four assessments), 17 cases fitted a response pattern identifying one of Clark's stages. Of these 17, it would have been possible for 13 of them to advance to a higher Clark stage, but this occurred in only four cases (shown in Table I by arrows). Child #8 accounted for two of these. This lack of stage progres-

TABLE I

Individual Response Patterns by Subject and Assessment Period

	Assessment Period							
	I		II		III		IV	
Subject No.	*ba*	*ba**	*ba*	*ba*	*ba*	*ba*	*ba*	*ba*
1	10	00	00	00	10	10(B_2)→	11	11(C)
2	11	01	00	00	01	11	10	00
3	10	00	10	00	10	10(B_2)	10	01
4	00	00	00	10	11	10(B_1)	00	00
5	11	00(A)	01	00	11	00(A)→	11	10(B_1)
6	10	10(B_2)	10	00	10	00	01	00
7	01	01	10	10	00	11	11	10(B_1)
8	00	00	11	00(A)→	11	10(B_1)→	11	11(C)
9	01	00	11	00(A)	11	00(A)	11	01
10	11	00(A)	11	00(A)	00	11	01	00

* b = before; a = after. The first ba under each assessment period represents a forward sentence construction; the second ba represents a backward construction. The digits in each column represent the response to the appropriate construction: 0 = error; 1 = correct; letters in parentheses correspond to the name of one of Clark's stages. Arrows indicate possible advances to a higher Clark stage.

Lexical Development: A Minilongitudinal Approach

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Many theories of lexical development, especially those which attempt to describe the acquisition of specific semantic domains, use cross-sectional data to describe the learning process. Although cross-sectional data provide adequate group norms, they do not necessarily describe the acquisition process for individual children. Because many lexical fields enter the child's vocabulary rather quickly, it is possible to study that acquisition longitudinally, and within a short, specified time interval.

The purpose of this paper is to demonstrate that cross-sectional data on children's lexical development may oversimplify the processes involved, and that "minilongitudinal" experiments—that is, repeated measures on the same children for a short specified time—are a more appropriate approach for examining lexical acquisition. Each child in our study was assessed at four separate times during a seven-month period. Each assessment represented both a separate cross-sectional study and a means to chart each child's progress and analyze his responses longitudinally.

A well-developed and extensively tested theory in lexical acquisition is Clark's stage theory (1971; 1973), which explains children's acquisition of the temporal adverbs *before* and *after*. As part of a longitudinal study of lexical development, we too assessed the acquisition of *before* and *after*. Briefly, if *X* and *Y* are clauses describing momentary events occurring in that order, then *before* and *after* can be used either to parallel the actual order of events (*X before Y; after X, Y*) or to reverse the order (*before Y, X; Y after X*). For example, Clark (1971), using a cross-sectional design, found that children between the ages of three and five pass through three stages in learning the meanings of *before* and *after*. In the first stage (A), children showed that they understood neither word by acting out the events in the complex temporal sentences in the order in which they were spoken (order-of-mention strategy). They performed correctly on *X before Y* and *after X, Y* (forward sentence constructions) and incorrectly on *before Y, X* and *Y after X* (backward constructions). In the second stage (B), children followed one of two routes. In stage B_1, they began to understand the meaning of *before*, which they demonstrated by performing correctly both on forward constructions and on the backward construction *before Y, X*. Children who took the stage B_2 route overgeneralized *before*, which they demonstrated by performing correctly only on constructions containing *before* and incorrectly on constructions with *after*. In stage C, children performed correctly on all test sentences.

In order to test Clark's hypothesis and thereby answer the question: Do individual children pass from stage to stage in an orderly progression? we must first replicate her stages cross-sectionally and then reanalyze the data longitudinally.

METHOD

Subjects. Ten children who were participants in a larger minilongitudinal study of lexical acquisition were studied. Their ages ranged from 2;4 to 3;1 (mean age, 2;9) at the first assessment period, and their Stanford-Binet IQs ranged from 111–154. All the children were native English-speakers.

Procedure. Each child was asked to act out a series of *before/after* sentences at each of four assessment periods, separated by six to seven weeks. All sentences were in the imperative mood and the verb in both clauses was always the same. During the first two assessment periods, every sentence used the verb *pick up*. The sentences were of the form: "Pick up X *before* you pick up Y," where X and Y were names of two familiar toys. During the third and fourth assessments, other action verbs were substituted for *pick up*. Each of the four sentence constructions was tested twice at each assessment period. After a sentence was acted out, the experimenter recorded the child's actions.

RESULTS

In order to test our methodological claim, it was necessary first to demonstrate that we replicated Clark's data cross-sectionally. If our data confirmed Clark's, we could examine each individual child's responses to see if, in fact, the data were consistent with her theory of stage progressions. Therefore, we conducted two separate analyses of the data. In the first, each assessment period was treated as though it represented a separate cross-sectional sample. The analyses were adopted from Clark (1971). In the second analysis, each child's responses were examined across the four assessment periods.

Cross-sectional analyses. The percentages of error responses were computed. Each child's response was scored as an error if: (1) he or she did not follow the described sequence in the correct order (reversals); (2) omitted one of the actions; or (3) carried the actions out simultaneously. Omissions and simultaneous actions accounted for 5 percent and 1 percent of the errors, respectively, across the four assessment periods.

Clark's first hypothesis was "*before* is simpler than *after* and would therefore be acquired earlier" (see Clark, 1971, p. 269 for a more detailed description). Across all assessments, *X before Y* and *before Y, X* in combination produced fewer errors than the two *after* constructions combined, 32% vs. 40%, respec-

sion may be partly explained by the relatively short time span for the longitudinal study.

Moreover, 26 of the 30 observed transitions were different sequences: 22 occurred only once, and four occurred twice. In other words, there were only four instances in which a sequence of response patterns from one assessment to the next was repeated. (These repetitions were made by subjects #5 and #8; #5 and #9; #9 and #10; and, #3 and #6).

Discussion

The purpose of this methodological note is *not* to test Clark's theory, but rather to support the basic methodological claim that repeated measures on the same children can give a much richer picture of lexical growth than do cross-sectional studies. The longitudinal analyses revealed much heterogeneity in the transitions from one assessment to the next. This response variation can be used to investigate the particular strategies used by individual children. It should be emphasized that the above data are merely illustrative of the kinds of information obtainable from minilongitudinal experiments. Replication with more children over a longer time span will be required before we can formulate a better theory of lexical learning in individual children.

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